Solar POWER System for RVs, Vans, Cabins, and Boats

Clark Thompson

Solar POWER System for Home

Clark Thompson

2 books in 1

The Perfect Guide for Beginners to Easily and Efficiently Plan & Install **Off-Grid Solar Power System** Indoors or Outdoors to Achieve Home Energy Independence

Solar POWER

FOR BEGINNERS

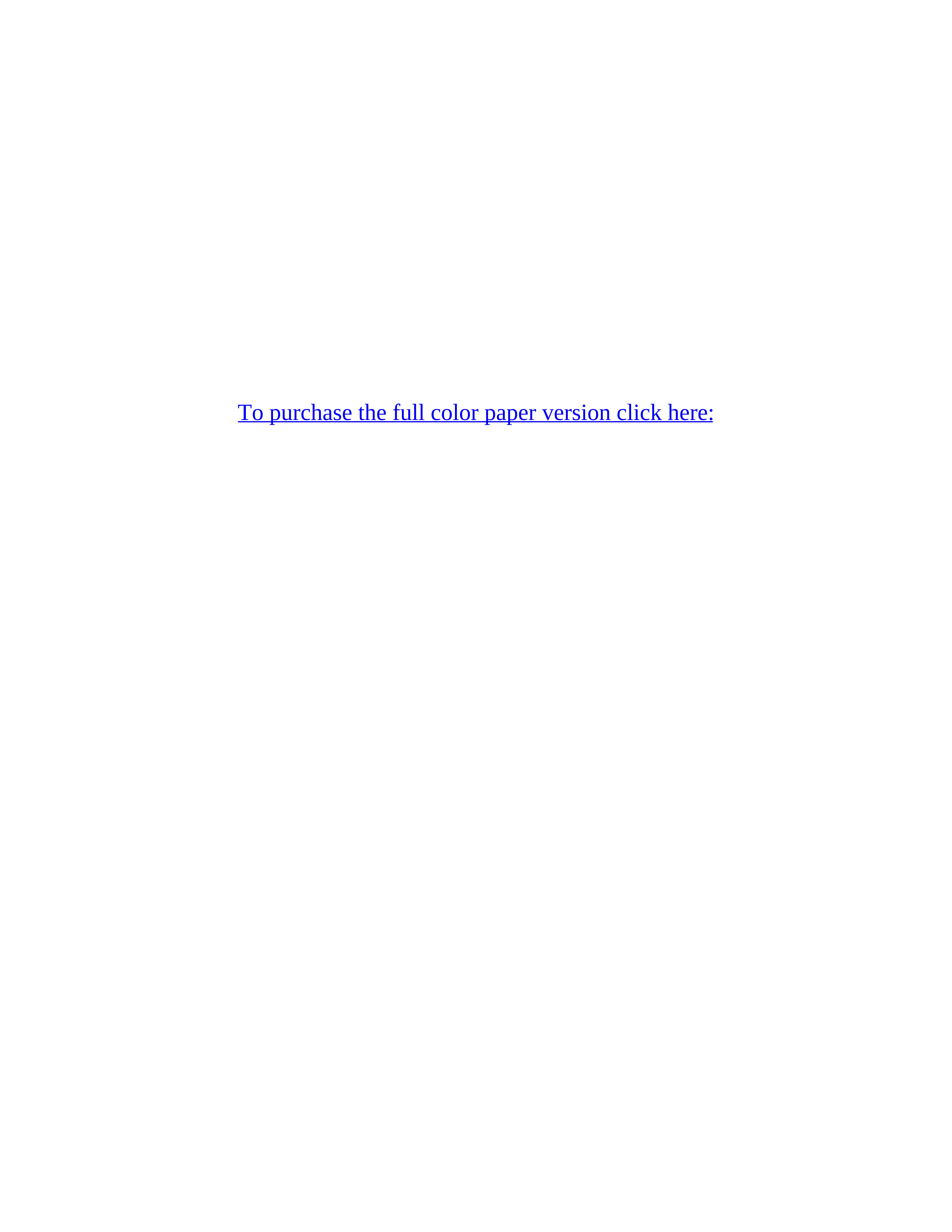
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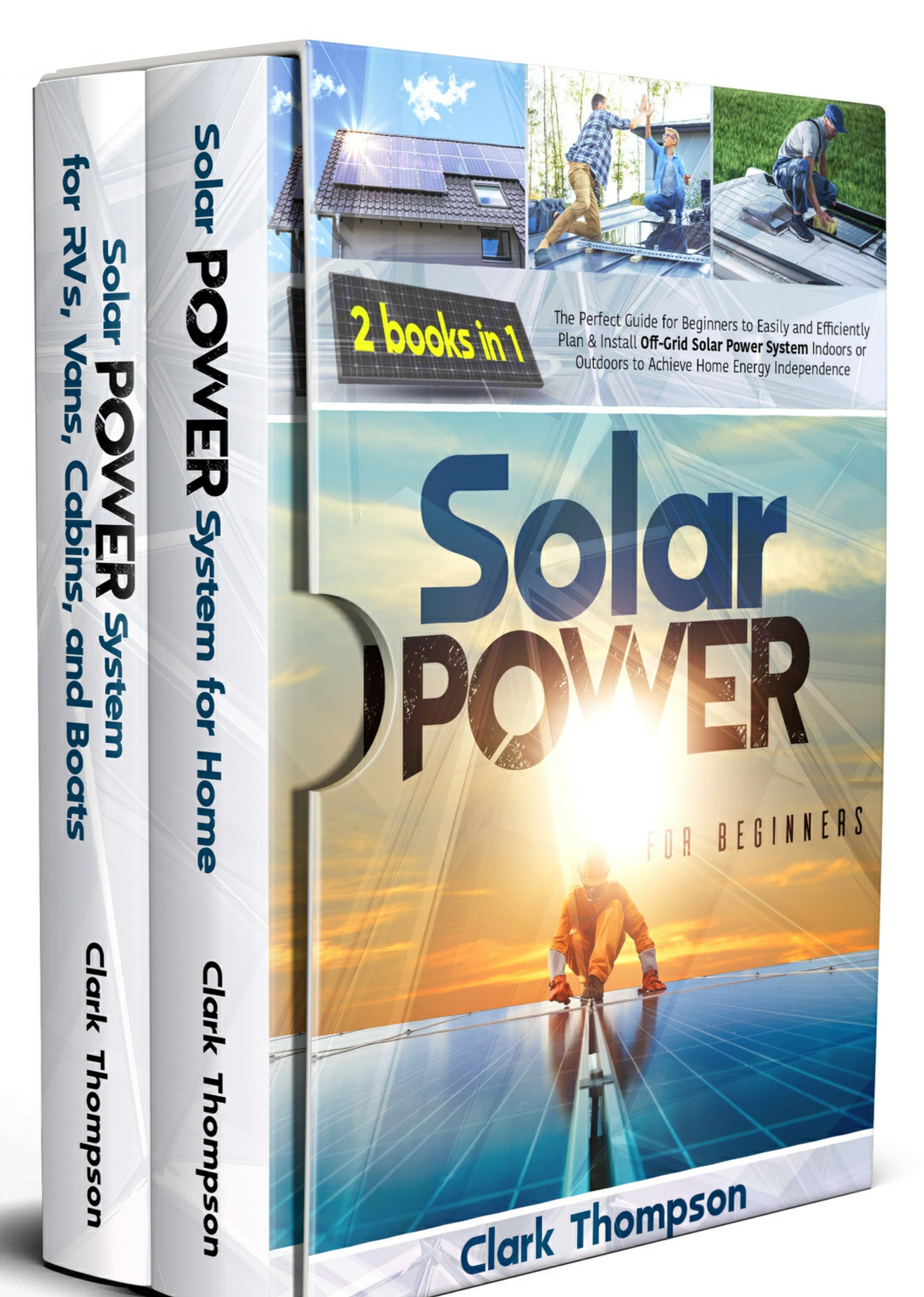

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INTRODUCTION

When solar energy systems were first introduced to the public, it was believed that they were only for the wealthy as they were incredibly expensive, even with the subsidies provided by many governments. However, as with all new technology, it is now much cheaper to purchase either the original equipment or the latest version. The result has been the possibility of creating your solar energy system and removing your RV from the grid. This will provide an enormous sense of financial freedom and release you from any uncertainty regarding electricity prices in the future.

In a world where there is a limited quantity of carbon fuels left, many scientists and even individuals are looking to devise new ways of creating energy. Of course, many countries operate nuclear power stations that provide them with all the electricity they need with surprisingly few environmental effects. However, a nuclear power station is inherently dangerous. If something were to happen at the power plant, it is possible to have a disastrous fallout, which could affect thousands of people.

As such, there has been a massive increase in interest in more passive, environmentally friendly approaches to creating energy. Wind and water power are two avenues that have been explored thoroughly within the last few years. Solar power is another potential solution to the energy crisis around the world. Many companies and even individuals have invested in their solar panels to generate electricity, assist the planet and save funds.

Solar power is the future of energy consumption as all the big corporations invest in gaining better technologies in this direction. This means that when you choose to move to solar energy, you can get the latest technology for power generation. Having the latest technology means that you have the best chances of utilizing power and energy.

Moving from grid to solar power has unique benefits, and now you know all about them. Understanding these benefits will help you make your final decision. Focus immensely on the quality of lifestyle and cost-saving

opportunities. You can have your energy supply and save throughout the year.

CHAPTER 1:

A QUICK INTRODUCTION

WHAT IS SOLAR POWER?



We hear about solar power in increasing frequency these days and that is because of two core reasons. The first is the environmental impact of non-renewable energy production. The fear of depleting that source of energy has expedited the development of alternative power generation technologies. This leads to the second reason: the precipitous fall in costs associated with the deployment of distributed solar-generated power.

The key factor that we must distinguish when it comes to understanding any kind of power generation technology is that power is not just influenced by its generation but also its distribution. The power ecosystem is characterized by centralized generation (regardless of the method of generation) that is then fed to a nationwide grid and transported over long distances. This has a two-pronged effect. The first is that it needs a huge capital investment to expand or maintain this grid. The second is that there are significant inefficiencies at play here. You have to generate a significantly higher amount of electricity to support the needs of a community when you need to transport that energy over wires because a large amount is wasted in transmission. Look at it this way, if water pipes were naturally porous (this is hypothetical to drive a point), then you would lose more water the longer the pipe distance (traveling from the source to use). So, you would lose less water if the source of water were two doors away compared to how much you would lose if the source were two towns away. Because at each length of pipe the water travels, part of it seeps out of the pipe. Thus, the water plant has to process more water to overcome the loss of this water. Processing water is expensive.

Now think about this same thing in electricity terms. The power generation company has to generate more electricity than is being used because it has to transmit that electricity over inefficient cables over long distances.

Since there are two factors at play here, there are two ways to reduce the burgeoning power generation cost and the old way's environmental cost. The first is to convert the methods of generating electricity. This is the kind of thing that Elon Musk has invested in (SolarCity – a company owned by Musk’s cousins).

The idea behind this is to have a farm of solar panels and then connect that power generation ability to the existing grid so that the power can be transmitted to the end-user.

TWO KINDS OF SOLAR POWER

As the name suggests, solar power is a power that comes from our sun. It is rather simple, and it can be broken down into two. The first is the use of the photons that the sun releases, and the second is to use the heat that the sun releases. They are not the same. To prove this to yourself, think about it this way. You know those tinted glass sheets that you stick on windows. Remember how it does two things. It reduces the light that comes in, but more importantly, it cuts out the heat. That's because it allows the photons of a certain frequency in but filters the heat out. So, from here, we know that there are at least two components to sunlight (there are more but outside the scope of this book).

The first kind of energy you get from the sun is the photon that carries light, and when you place a photovoltaic sheet in its path, the photon that hits it release the electron in the sheet. That electron then flows to wherever you want it to along the cables that are attached. In that form, you get direct conversion of energy from the sun.

The second is the heat that the sun emits. This is a kind of energy too, but it is a little different from flowing electrons (which we call electricity). Solar panels that extract heat use that heat to raise the water temperature, and that hot water is run through radiators and water tanks for showers. These are closed systems and can be used during the day, but need to be supplemented with another heat source during the night. We will get to that as the book unfolds. Still, for now, the point that we are trying to make is that you should look at solar power as two distinct types – electron generation for electricity, and heat capture for temperature modulation.

TERMINOLOGY

Cell

Cells are the fundamental components of every solar module and can be found in almost all designs, regardless of the manufacturer. It is akin to a battery cell in that it is the smallest structural unit of the battery.

CO2

See Oh Two — we all know what that is — it is the chemical abbreviation for Carbon Dioxide, a gas that is a product of respiration in all living tissue and it is the byproduct of combustion. In the context of energy, Carbon Dioxide will typically refer to the emissions created by the combustive processes of a system.

Conversion Efficiency

Conversion Efficiency is the term used to determine the efficacy of the equipment. It measures the number of light photons that are converted to electricity. Both are theoretical values based on what we have observed. We can calculate how much photon is entering the system based on the exposed area and the intensity of the light (and the frequency of the light). We then measure how many electrons are generated by setup. The number of electrons is calculated by measuring the amps generated. The resulting ratio is then expressed as a percentage of one to the other. The more efficient a system is, the more electricity you can generate for the cost of the system.

Energy Payback

This is an interesting term because it is rather convoluted if you don't stop to think about it. Panels require energy to construct. Manufacturers calculate the amount of energy it takes to make these panels. Then they calculate the amount of electricity the panel can generate and divide how much electricity is used to manufacture it by the amount of electricity it can generate in a year. The resulting number is the number of years it will take to break even in terms of the electricity used and the electricity generated.

Grid Connected

When the solar generator generates excess capacity, the excess energy can be sold back to the utility company via the grid. If you are off the grid, you can't sell the electricity back to the utility company and your excess will be wasted. But if you are grid-connected, you can direct the system to push it back to the grid. For instance, this is truly beneficial when you are away on vacation and your consumption is minimal. The bulk of the electricity generated can be sent back into the grid.

Inverter

If you are grid-connected, you need an inverter to convert the DC that the solar system generates into AC (Alternating Current).

Micro-Inverter

There are also such things as Micro-Inverters. These are for smaller loads and are typically installed in individual panels to execute the conversion after electron generation immediately.

String Inverter

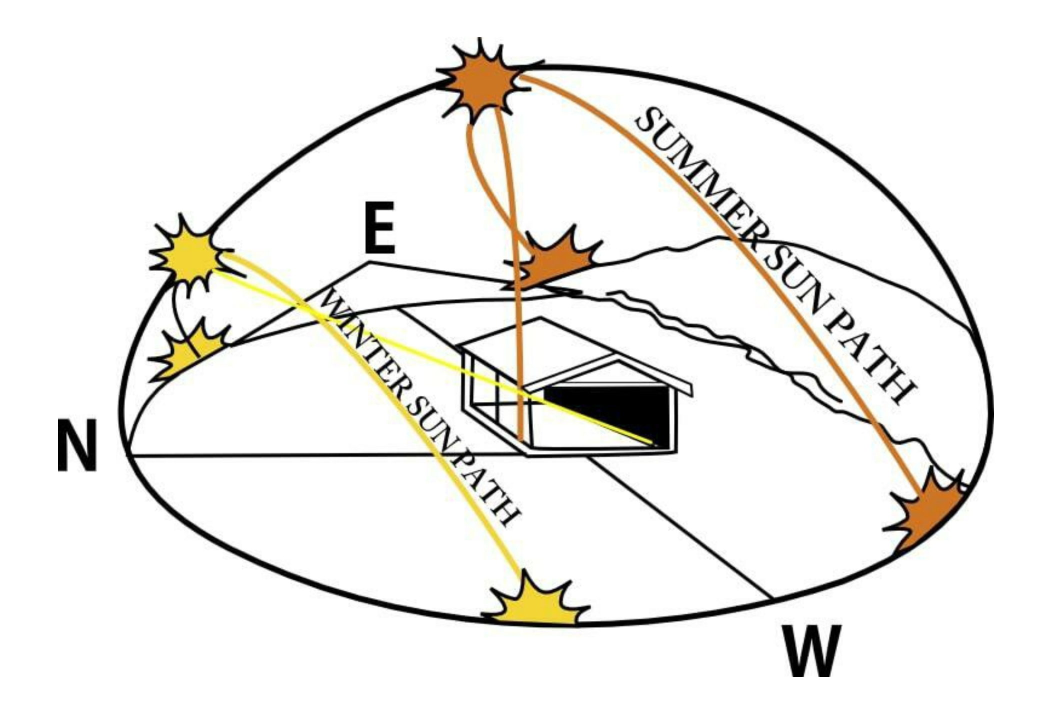
These are the most common of the inverter family and are typically used in residential systems to convert DC to AC.

Central Inverters

As we have described, these do the same thing but are typically used in much larger commercial photovoltaic systems.

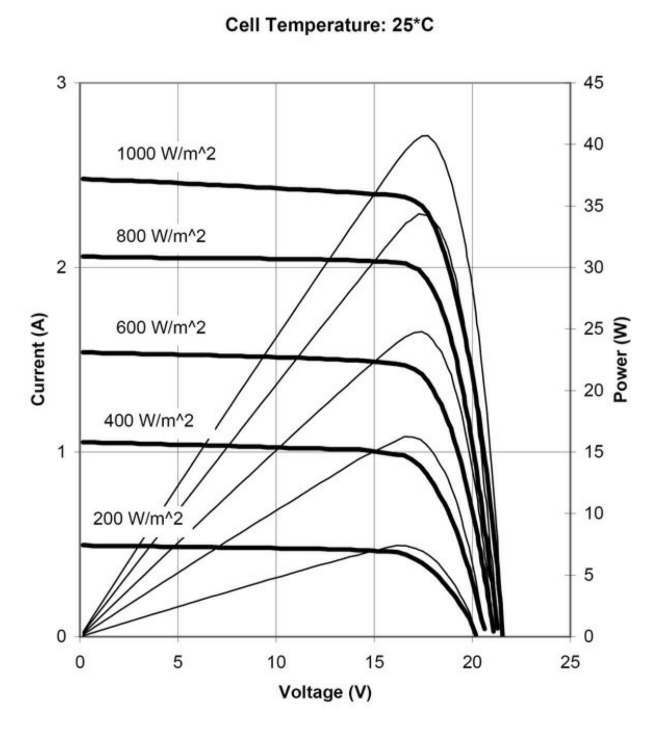
Insolation

Insolation (not to be confused with insulation) measures the amount of energy radiated by the sun in a certain geographical location. You see, one of the things that affects the density of photons to hit the surface of the earth is the angle in which it hits — that angle depends on the latitudinal position that is being measured. It also makes a difference if the light is direct or diffused. Strong insolation refers to the higher density of photons, and as such, it is better for photovoltaic systems. For example, Alaska and parts of Canada have some of the lowest insolation, as opposed to say, Florida or Texas, which has higher insolation. Insolation also changes during the year, as the sun makes an apparent move into the north during summer and south during winter.



https://www.australiansolarquotes.com.au/solar-energy-matters/

https://electronics.stackexchange.com/questions/268025/solar-panel-output-voltage-drops



kWh

kWh stands for kilo, meaning thousand; Watt, the measure of power; and

hour, the period it is measured. It is the unit of energy that most current and power consumption is measured by. A kilowatt-hour is the use of 1000 Watts of energy in an hour. You know the measure of a light's wattage — let's say 100 watts. Imagine using ten of those 100-watt bulbs for an hour — that is a consumption of one kWh. When you pay your utility bill, the amount of power you consume is measured in kWh and charged at cents per kWh.

Micron

This is a measurement in the metric system. Like the American measurement of the millionth of an inch, a micron is a millionth of a meter. In cell production, manufacturing steps occur in dimensions measured in microns.

Module

A PV module, or Photo Voltaic module, is a group of PV cells that have been electrically tied together. These modules are what are usually referred to as solar panels. Each module is covered to protect it from weather, typically with tempered glass.

MW

MW stands for megawatt, or 1000 kilowatts, or one million watts.

Net-Metering

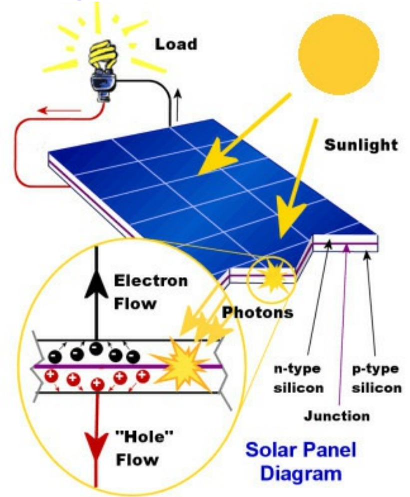
This is more of an accounting term than it is an electrical or photovoltaic term. But it does nonetheless become relevant if you are pushing electricity back into the grid through your utility. As the term suggests, it nets out what you take versus what you send back. You could use a certain quantity of electricity during the month (let's call that X), and you could also be producing power which you send back to the grid (let's call that Y). The net would be X minus Y. Your meter will turn one way when you use the power company's electricity in one way, and it will turn in reverse when you send electricity back. You will turn back the meter by doing this, and what happens is that your monthly bill gets reduced by that amount. Most utility companies will carry forwards the difference if there is an overhang rather than send you a check for it.

Photovoltaics (PV)

Photovoltaics refers to the generation of electricity by light. The term photo means light, and volt refers to the electricity potential.

Polycrystalline

Poly indicates many. Crystalline refers to the silicon crystals that are used in the cells of the PV panels.
https://commons.wikimedia.org/wiki/File:Silicon_solar_cell.gif



Silicon

Silicon is a Periodic Table element that is the fundamental ingredient in the construction of PV cells. In essence, it is what makes sand and is the main ingredient in glass and computer chips.

Silicon carbide

Silicon carbide (SiC) is a compound made using Silicon and Carbon (also another member of the Periodic Table). It is an abrasive used extensively in the manufacturing of panels in the PV industry.

Stand-alone system

This is a solar system that is not feeding excess back to the grid. It is not even connected to the grid. These are what we usually refer to as off-grid systems and are self-sufficient. They store the electricity generated in batteries and are used when the photovoltaic panels do not get enough sunlight to generate the required power.

Wafer

A wafer is a slice of silicon disc that forms the start of the cell's manufacturing process.

BENEFITS OF SOLAR POWER

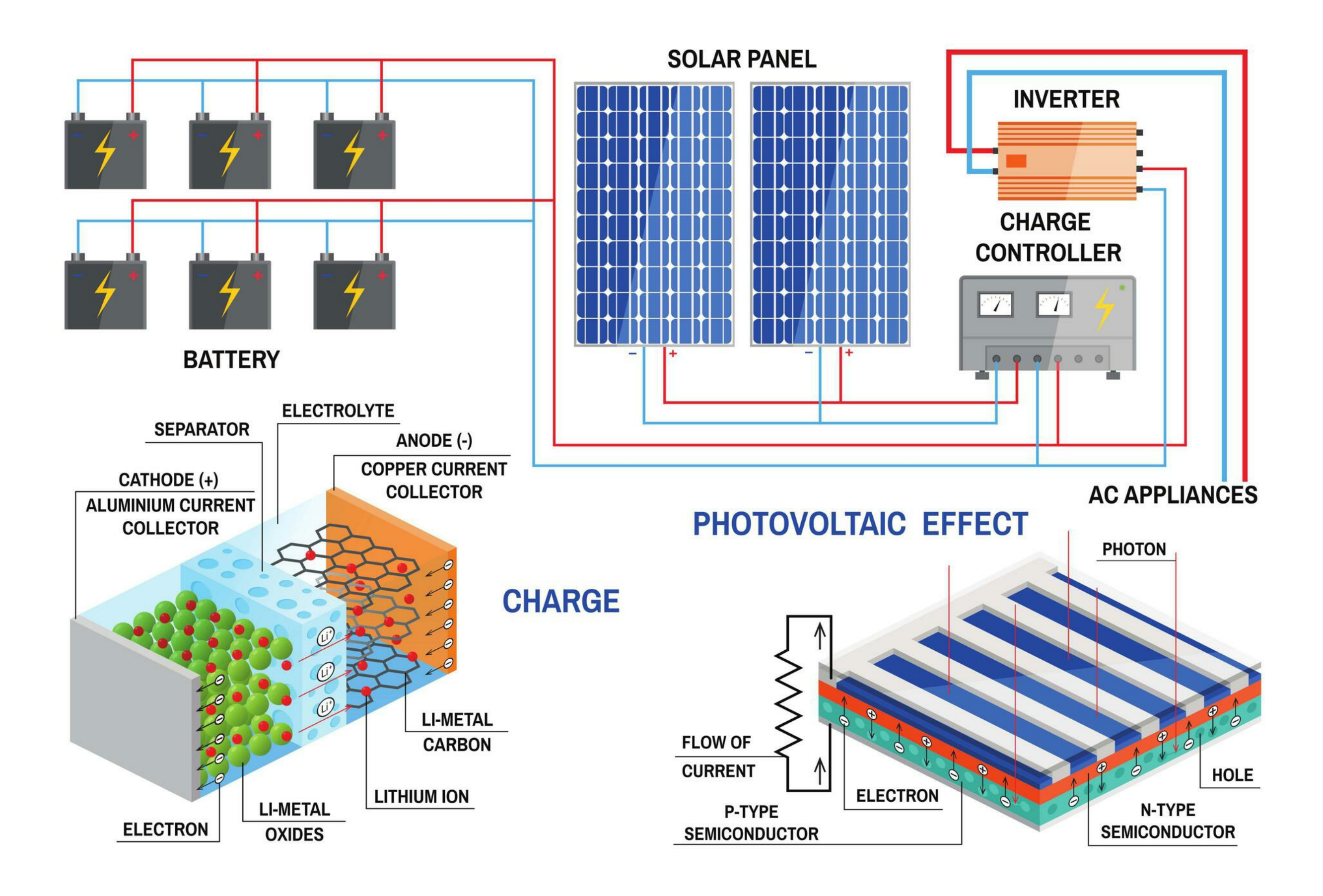
Solar power is significantly beneficial when you look at it from a scaled perspective — meaning it has overreaching benefits for all of humanity and the rest of nature because the conventional sources of electricity generation hurt the health of living organisms and the environment as a whole. Solar energy can generate electricity in a way that does not have any of these effects, making clean energy a significant reason for its shift.

But more importantly, there is one economic reason that most individuals and societies fail to realize. Non-renewable resources are coming to a point where supply certainty is coming into question. Mining costs and exploration costs are increasing to the point that other forms of energy extraction are becoming comparatively less economical and more expensive. That increased cost affects everyone. It translates to higher input costs for manufacturing, thereby higher costs of goods ranging from food to clothing and transportation to housing. Indeed, it touches all layers of the economy.

Aside from rising costs, there is the annoying instability of costs that affect households. The cost of power can fluctuate as time goes by, and as average temperatures start to rise, the cost of cooling homes and offices is starting to place a demand on the power grid. There are cases where you observe rolling brownouts in neighborhoods with sweltering heat in the summer. A house fitted with supplemental solar power will not be a victim of those brownouts, or out and out power disruption.

Often, we limit ourselves to what we want to use in the RV that may strain the costs of power. With a solar system in the house, we no longer have to limit our electricity use because the electricity we demand is not derived from a non-renewable source. The increased demand we place has no adverse effects on the planet, our neighbors, and our future generations.

CHAPTER 2: BATTERIES



WHAT IS THE SUPERIOR BATTERY TYPE?

So a lot of off-network energy frameworks have dead lead corrosive batteries around the US that a narrative covering every one of them would run for quite a long time before depleting them all. Additionally, it is hard to accuse the entryway of the lead-corrosive batteries: they are intended to labor for a couple of years, which is their main event before blurring and losing their charge profundity. Lithium-particle batteries, then again, while impressively more muddled than their lead partners have some outstanding points of interest. There is no contention that lithium batteries are prevalent. Let us inspect precisely why this is so:

LITHIUM-ION BATTERY

The size and weight of the lithium battery are predominant. Lithium batteries are significantly more modest than lead batteries. Indeed, lithium batteries are just a third of the size and weight of the run-of-the-mill lead battery. The charge limit is like that of the lead battery, something made conceivable by the lithium battery's boss energy thickness. The higher energy thickness improves arrangement and establishment to an extensive degree.

THE STRENGTH LEVEL OF LITHIUM IS SUPERIOR TO LEAD

As you may surely understand, all batteries might be rapidly and broadly harmed when unnecessarily released. The equivalent is the situation when the battery is put away at outrageous temperatures. In any case, the lead battery is much less enduring of this roughhousing and is unavoidably harmed when more than once released excessively fast. On the off chance that the lead battery is released underneath a large portion of its State of Charge (SOC) or released quicker than C/8A (C8 rating implies the battery is released over a time of 8 hours), it loses possible cycles.

Contrast this with the lithium battery: it very well may be released to up to 80% of its SOC and at a high C/2 rate(C/2 rating implies the battery gets completely released over a time of 2 hours), and there is no drawn-out harm to show for it. On the off chance that you have no designs to continue changing batteries at regular intervals while being very cautious with them, the lithium battery is the ideal alternative.

THE LIFECYCLE IS PREDOMINANT

Let us talk about battery costs. It's an obvious fact that the lithium battery costs you significantly a larger number of dollars than the lead battery. With time, this will change, and the lithium battery will cost much less (projections state that costs will dip under $400 per kWh). Just like the case with numerous things, a lower cost for a specific item (Lead battery) compared to another (Lithium battery) doesn't generally make it less expensive. Some savvy individuals once said "modest is costly": this is the thing that we are implying.

Take a gander at it along these lines: a lead battery, while costing less, will require bunches of upkeep and you will unquestionably need to supplant it after some time. A lithium battery, while costing more, requires insignificant upkeep; it is significantly more lenient to harsh treatment and has a life expectancy approaching that of, state, 3-4 lead batteries.

WHAT DO YOU DO AT THIS STAGE?

The lithium battery is, without a doubt, the better battery. The lead battery has served the world for almost two centuries, so it can't be attacked. If cash is an issue, begin with the lead battery while hoping to move to the lithium battery later.

Since you think about batteries, sun-oriented boards, and other important data to begin, we should discuss wires and the wire box that you require for the establishment.

STEP-BY-STEP GENERAL INSTRUCTIONS TO INSTALL YOUR BATTERIES

Before installing them, follow the manufacturer's guide to setting up your batteries. Remove packaging and protective coverings as instructed.

Place the battery in the location that you have determined. If there are ties in the case, you can tie them down, or you can use 2x4s to form a barrier and anchor the 2x4s to the chassis and then tie the batteries to the 2x4s. Make sure the batteries are stable and do not have space to rock or slide. They should also not be able to hop either, in case you hit a bump. For this, place a 2x4 on the batteries to anchor those down as well.

TIE THE TERMINALS IN PARALLEL OR SERIES THE WAY YOU HAD PLANNED TO

Run the wires (after calculating the proper gauge) from the common line leading to the fuse box that leads to the solar charge controller.

Then, connect the wires leaving the batteries to the fuse box that will lead to the inverter and the DC outlets.

Make sure that you insulate all the wires and anchor them to a stable surface. Never leave your wires in a bunch, and do not leave them hanging.

HOW TO DETERMINE HOW MANY SOLAR PANELS AND BATTERIES NEEDED

The 2000 to 3000 Watt true sine wave inverter should be enough for an average camper power requirement and you may spend up to $2500 or $3000 to complete the purchase and set up of your equipment.

Your storage batteries — the storage facility for your solar panel system

Without your storage batteries, you will only have solar power when the sun is shining. There are four basic types of batteries you can consider for your Solar power system, these are:

- The RV or Marine storage batteries are ideal for small systems, such as campers and boat drivers. These batteries must be handled lightly because they can be damaged internationally when discharged excessively, they are the least expensive storage batteries, perfect for small systems.
- Flooded type storage batteries — These are lead-acid batteries with caps for water storage. These batteries are reasonably priced and can work for many years. These batteries release some gas when charged; hence they cannot be placed indoors. These batteries also need some venting because the gases they released can be explosive.
- The AGM storage batteries — Also known as “Absorbed Glass Mat batteries” is the best available solar power storage battery. It comes with a woven glass mat placed in-between the plates to hold the electrolyte in the battery. This type of battery is leak-proof and does not release gases while charging. This battery is a

sealed gel type and maintains its voltage and high quality much longer. This battery is typically more expensive, but you will get more value for your investment.

- Gel storage batteries are industrial grade lead-acid batteries that do not release gas during the recharging process and have no vents. These batteries can be placed indoors and they have the advantage that their temperatures are constant; hence they perform much better.

You can determine how charged your batteries are through the use of voltmeters.

Note: Knowing how to take care of your storage batteries is important to extend their lifespan. You need to pay more attention to the temperatures and humidity. The battery capacity is normally rated at 77degrees F hence the temperature must not go beyond this. You need to note also that battery voltages drop as they get colder; hence their performances may drop significantly. You should consider AGM batteries because they can be stored indoors hence you can protect them from excessive heat and coldness.

How deeply you discharge your battery is another factor you must consider. You need to consider how long you allow voltage drops before you recharge the battery. You need to keep batteries recharged as often as possible to keep their lifespan high (don’t let charges dropped below 50% before recharging). Batteries can withstand dropping in charges for up to 20%. The Trojan L-16 flooded battery is a wonderful and economical battery recommended for small system solar power structures and they cost less than $200.

CHAPTER 3: TOOLS



MATERIALS AND TOOLS FOR BUILDING SOLAR POWER SYSTEM

We have discussed the various components that make up an off-grid solar power system; however, there are a few supporting materials and tools that you must have when installing the system to perform successfully. These materials and tools can be purchased from a local DIY store or RV Depot and stored in your RV for future solar projects.

Solar systems mostly require standard household tools such as a screwdriver, hammer rails, ladders, etc. Nonetheless, there are a few custom tools that you will need to purchase, which are designed to help you install the solar system. Some of these tools are utilized for simple applications, and others for more complex operations. For those looking forward to installing a home's off-grid solar power system without professional help (effectively making it a DIY project), you need to make sure you have purchased tools for physical application, such as things to install racking. Furthermore, some states require an electrician to visit the site and check the connections before switching on the system. Contact the local authorities and inquire about any procedures you need to follow before and after successful installations.

SAFETY COMES FIRST

I have put safety equipment at the top of the list because you cannot perform any task without protecting yourself. Safety equipment and accessories such as ropes, ladders, harnesses, safety goggles, gloves, safety suits, earplugs, helmets, and safety boots. I recommend you purchase as much safety equipment as you can because it will reduce any risks of injury when you are installing your system.

SITE ASSESSMENT

You will need materials and tools to perform a site assessment. Every successful installation has to begin with establishing the layout of the solar array. Therefore, you will need a fairly large tape measure (consider using two tape measures one being a 25-foot and the other being a 100-foot), white chalk or string line to demarcate the area where to position the array and a solar pathfinder which will show the most efficient solar array location and position on your plot. Don’t feel you have to rush the planning process because any mistake in positioning the solar panel array can cost a lot of time and money in the future.

If you have chosen to mount the panels on a rooftop, you will need a suitable-sized ladder to reach the area to place the panels. When the layout is on a pitched roof, find the location of the roof rafters or trusses. Do this by tapping on the roof with a hammer to sense the location of the roof’s structural support audibly. Once you have found a rafter, mark the location with a pencil and measure 18 to 24 inches, reach the next rafter, and place a pencil mark there. Once all of the rafters (top and bottom) are marked, you can start drawing lines to mark the rafters lengthwise and follow by marking the locations of the stand-offs and the rails to complete the pitched roof layout.

Planning installation for flat roofs is far less intricate because the measurements only require you to decide whether the solar panel array will fit perfectly on the roof’s surface area. However, if you decide to mount the solar array on the ground, locate the support posts for the racking. This can be done by contacting the local utility company to find and mark the underground lines (this service will be free of charge and must be done before you can proceed with the layout). A solar pathfinder is a useful instrument for this ground-mounted solar layout because it will show you the best position for the structure (azimuth angle).

STRUCTURAL SUPPORT MATERIALS

Depending on the method desired to mount the solar array, you will need different structural support. For instance, if you are mounting the panels on a pitched roof, you will need to have a cordless drill and an impact drive, drill bits, a utility knife, sockets, and a caulking gun. Ensure that you first drill a pilot hole, so you don't split the rafters; a pilot hole should also make installing a stand-off anchor bolt a lot more convenient using an impact driver. The utility knife will come in handy by trimming off any roofing material to install the flashing (inserted around joints or cracks on a roof to provide a water-tight seal).

Flat roof structural support is a lot simpler. Most of the time, a ballasted racking system will provide support for the panel array. You might need to use a broom to remove any dust or dirt on the flat room, especially within the installation area. The only difficult part of this installation will be carrying the heavy ballast weight onto the roof. In extreme cases, you can rent a forklift or a crane to lift the weights. Ground-mounted solar arrays require holes in the ground to anchor the posts in concrete. Digging holes is difficult and time-consuming, so schedule enough time and human resources to complete this task effectively. Ensure that the posts are planted straight in the ground by using string lines as markers.

RACKING

Once the structural support is installed, you can proceed to install the racking. The racking will help fix the panels securely on any surface. The method of inserting the racking is similar for every mounting type, and usually, you will only need to use one socket size for the whole racking installation. Use a torque wrench to insert all the necessary bolts and a cordless reciprocating saw to install the rails on one side of the array and only trim the rails according to the perfect fit once all of the panels have been installed seamlessly.

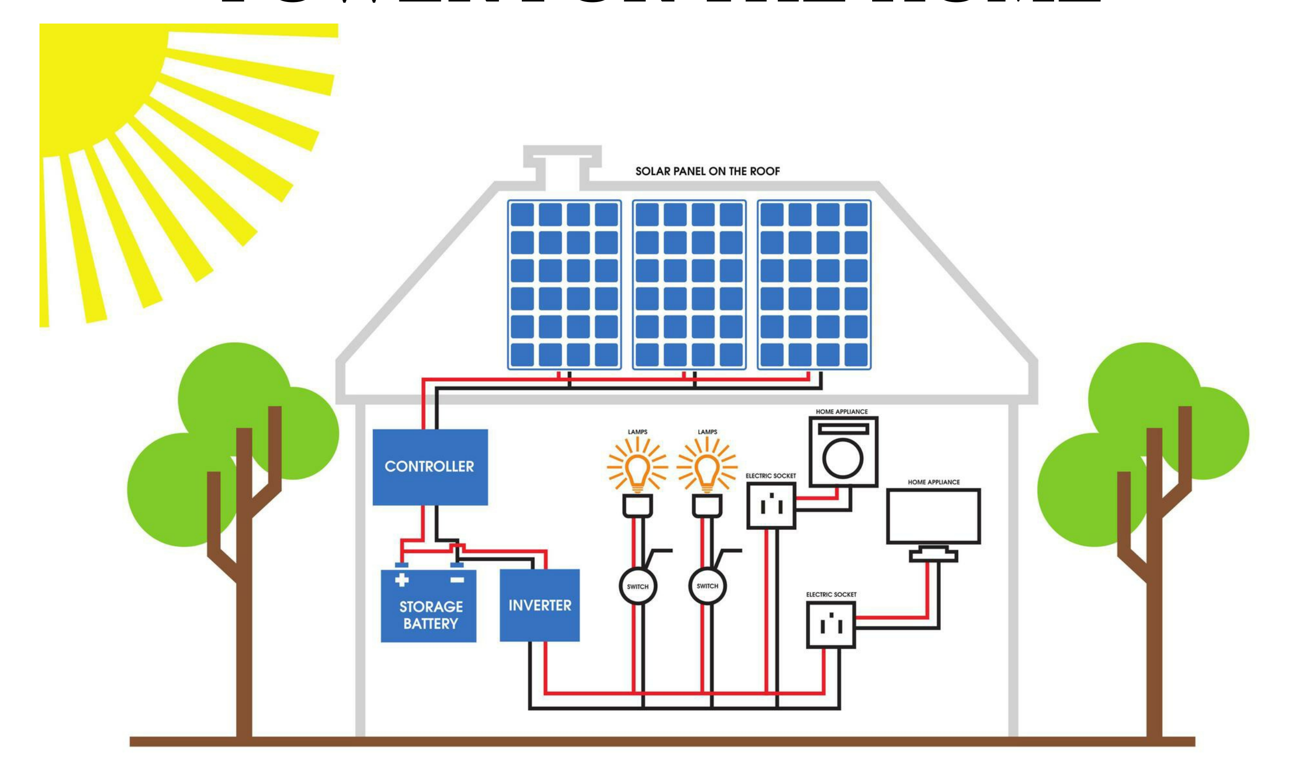
GROUNDING

All PV solar power systems require the equipment to be grounded not to move or shift from their location. Ground the equipment with wire cutters, using a flat-head screwdriver, using a drill for installing lugs, and a flat-head screwdriver for tightening the installed ground lugs (inserted on the back of roof-mounted systems).

WIRING

Even though connecting the panels in series will not require any tools, you will still need the tools for taking panels apart. Another great use for tools is creating a home-run wire that utilizes custom crimping tools to securely establish a connector on the appropriate wire matching the panel connector. Once you have successfully installed a positive and negative home-run for each string, you need to inspect the voltage using a multimeter. When you inspect the voltage after each string is in place, confirm you have properly installed the wires and reduce the risk of experiencing issues later on in the installation.

CHAPTER 4: SOLAR POWER FOR THE HOME



HOW TO INSTALL YOUR SOLAR PANELS

Now we come to the point where we have all the equipment planned and have all their specs. We want to put them together virtually. Never buy the stuff until you have exhaustively planned everything out. If you want to have some fun with it, you can even do a mock-up of it with all the equipment after purchasing them to see if it all works. If it all works, then you can start the installation process in this case. As you can see, this takes quite a bit of planning. It is also an iterative process, and you should bring lots of patience to the table.

INSTALLING SOLAR PANELS

Once you have your solar panels, there are several ways that you can get them installed onto your roof with the least amount of risk of damage to the roof, and the highest assurance that they aren't going to get blown off in the wind the moment the speedometer hits 60 mp/h (or 100 km/h for us metric folks).

The best way to do this is to line up your solar panels and lay them down width-wise so that they line up next to each other.

Use heavy duty aluminum rails and lay them parallel on the ground

Use shorter aluminum rails as crossbeams and use two crossbeams for every three feet of length. (Let's say you have a ten-foot run from the front of the RV to the rear, then you will have ten feet of aluminum rails going from front to back. The cross beam will go perpendicular to this and will be placed no more than 3 feet apart, in this case, since you have a ten-foot run, use for cross beams at an equal spacing of 2.5 feet.)

The cross beams should extend from the base of the solar panel by at least 6 inches. This is to hinge it to the roof of the RV. In this example, there will be four hinges. When you plant the hinges on the roof, make sure to use a vulcanized rubber/silicone bushing to serve as a sealant for the holes and to keep the vibrations to a minimum.

Attach the panels to the long beams and run the wiring in a flexible conduit. Anchor that conduit to the rails. Remember, while you are cozy in the driver's seat driving to your favorite destination, the cables, and solar panels will be subjected to 60 mph winds. Everything here needs to be anchored down.

Place two locking mechanisms on the opposite side of the hinged rails and lock those down when you are on the road.

Bring the wires down to the junction box where the fuses will be located (more on this in the next section.)

REASONS WHY YOU SHOULD LOVE DIY SOLAR POWER FOR HOMES

It is straightforward now to know how to install an RV solar power system. To learn how to install the systems yourself in a few days and at lower costs (for less than $200!) and buy DIY solar electricity company manuals for your projects!

In 2009, the US government decided to offer energy efficiency Federal Tax Credits. The tax credit for households installing solar power systems would cover 30%, with no limit to 2016 (both existing homes and new buildings), thus lowering costs for building the solar energy system.

Solar conversion efficiency is rising, and prices are decreasing thanks to the development of solar technology. This means you can pay less money plus produce better household energy.

America is in the world's top five nations that embrace domestic solar energy. Solar energy is currently installed in only 20,000 households. (Reuters, 2009) So you'll be the pioneer of your peers in the use of renewable energy. Your effort to protect our world will be appreciated.

People are now aware that oil and coal are the primary sources of power, causing severe pollution and other environmental issues. We are finding alternative energy to save the world.

FOR HOUSES

Reducing your carbon footprint, improving energy efficiency, and saving money are all possible with solar panel installation in your home; however, it all comes down to how you calculate energy consumption.

You will require peak sunlight hours, household energy necessity on an hourly basis, and wattage of each panel. Multiply the hours with energy requirement and divide it with the wattage of one panel. This way, you will find the number of solar panels required in your home. You can choose a low or high wattage panel ranging from 150W to 370W. These are average power wattage that works for households. You will require between 18 to 40 panels to generate about 10,000 to 11,000 kWh every year. All these calculations will depend on the following factors:

Current kWh Consumption In Your Household

Look at the electricity bills you are paying for the last few months. This illustrates a better concept of energy consumption in your home. Divide the value provided in the bill with 30 to get the daily energy requirement. Multiplying this per day consumption with 365 will give you the energy consumption for the whole year. On average, a medium-sized home requires about 200 kWh every month.

A Size that Suits Your Home Design

Apart from the numbers, the size of the panels matters too. For that, you need to give a close look at your roof location. It is all about achieving the desired output with maximum sunlight exposure. A limited area in your roof will restrict your ability to get larger sizes; however, you can compensate by choosing higher efficiency panels in small sizes.

For residential purposes, you can find approximately 60 inches by 40 inches; however, the sizes differ depending on the manufacturer you choose.

CALCULATING YOUR ENERGY CONSUMPTION AND SIZING NEEDS

Sizing requirements of solar panels change according to the energy consumption you desire. Here are all the major applications where you need to calculate energy consumption and understand the required size of solar panels.

ELECTRONIC DEVICES

When finding sizing needs for electronic devices, focus on the following factors:

The Energy Required by the Device

First of all, you need to know the energy required to run your device for a specified period. Most devices provide power usage in watts. You need to multiply this given value by the number of hours you desire to use your device every day. This will inform you about the daily energy required to use your electric device.

Energy Generated by a Particular Solar Panel

The next thing to calculate is the energy generation capacity of a solar panel. Here, you will also have to see the power in watts. This is the energy that your device will receive via solar panels; however, it comes down to the time of sunlight exposure too so keep that in mind. Now, multiply the power generation capacity of solar panels and match it with the batteries you have.

Finally, you can include weather conditions according to the time of year and match it with your energy consumption requirements. This will provide you a precise number related to power, which you can incorporate when selecting a solar panel size.

ENJOY TAX CREDITS & LOWER BUILDING COSTS

You can also benefit from using solar energy by breaking off when solar power is installed for households at tax time. The US administration is aimed at promoting ‘green energy’ and environmental conservation.

If you have a solar power plant that means that you will have a reliable, safe, and permanent energy source in the future.

You don't have to spend much money on the solar power system. The need to remove or replace the pieces is rarely required, saving you a lot more money in exchange.

MAKE A CLEANER ENVIRONMENT FOR OUR CHILDREN

To think big with RV solar power allows you to be one of the people who will protect your planet for the next generation. You won't create air pollution anymore if you use renewable technology.

Solar energy usage will keep the world from being more polluted by using environmentally sustainable resources. Your children will appreciate what you choose to do today.

SOLAR POWER IS THE BEST SOLUTION

We have also found that the energy supplies that we use today will very quickly vanish, and the only alternative is solar energy. Not just recognizing the crisis, many people take measures to get solar electricity to their homes.

The disaster that you are avoiding by using renewable energy resources is very easy to imagine. So why don't you begin planning?

WHAT IS ELECTRICITY, AND HOW IS IT MEASURED?

In simple terms, electricity is the movement of electrons or charged particles in a circuit. There is electricity all around us and even within us. We use electricity to accomplish work because electricity is one of the easiest forms of energy that can be transported long distances. We have muscular energy in humans, but that’s not so easily transported.

To understand electricity, we need to start with something a little more basic elements. All elements are made up of atoms. You find elements on the periodic table. Atoms consist of protons, neutrons, and electrons. We are all familiar with the atom from high school. It consists of a proton and neutrons that form the core, and electrons that orbit around it. All of that—the protons and the neutrons in the center, and the electrons as well as the space between them—are all part of what we come to know as the atom. An atom is not stationary. It's not like having a grain of sand. That grain of sand (not considering that it is also made of atoms) is a stationary object. If you could see an atom, you would see that it is dynamic—constantly moving and constantly changing. The only time that it comes to a stand-still is when you freeze it to absolute zero.

The protons in the nucleus attract the electrons that are in orbit. The electrons occupy different shells, which is another way of referring to the altitude of the electron from the proton. For this part, you can imagine the planets that orbit the sun. Each shell on the atom is like the different orbit of planets, except in electrons, each shell can house more than one electron. The outermost shell holds electrons that are called the valence electrons. These outermost electrons experience the least amount of attraction from the atom's nucleus and are the easiest to pull away.

Volts

When that electron is pulled away and travels along a path, it has to move in a certain direction. An electric field determines that direction. The details of this are beyond the scope of this book, but the point that you must take with you is that the electron will move from the area of high concentration to an area of low concentration. The greater the difference between the higher and the lower, the greater the potential. The greater the potential between the two ends, the stronger the push of electrons in the circuit from the high to the low. That potential is described by volts. You hear it often that something is 12V, 24V, or 110V. This is often described by analogies using water pressure to illustrate volts. Take a tank that has two chambers separated by a valve. On one side there is no water, and on the other side, there are about three feet of water in the chamber. The pressure exerted by the three-foot column will make the water push into the empty chamber. It will start with more pressure, and as the column gets lower, it pushes less until the two chambers have the same height of water. At that point, there is no more push. There is no longer any difference in the pressure of the two.

In almost the same way (but not exactly), when a circuit is closed, the electron is pushed from the start to move and that knocks out the electron in the atom closest to it. That electron then goes to the neighboring atom and knocks out the electron in its outermost shell. That keeps happening along the length of the entire circuit. The easier it is to knock an electron off its atom, the more conductive the material is. The more difficult it is to knock an electron off its outer shell, the less conductive.

When you have a battery, the voltage of that battery tells you how much push it has. Imagine a trolley is carrying a couple of robots. That trolley moves through hurdles and traffic to get to different city areas to deliver the robots to do mechanical work. The trolley is pushed past obstacles and friction, then gets to its destination. The robots get down and do the work, then get back in the trolley and go home. If you have a huge bodybuilder, say Arnold Schwarzenegger in his prime, you will be able to push that car easily. If instead, you get someone like Pee-Wee Herman to do it, he wouldn't be able to push much of a load. If you get a toddler, then the possibility that the kid can move the trolley even a little is an issue. The force is what voltage is. It tells you how much of a load it can push through. Arnold would have much greater voltage than the toddler.

Current

The second thing in electricity that you hear all the time is amps. Amps is short for ampere. This is the measurement of current. So the next question is then, what is current? Simply put, the current is the rate of charge flow.

If you recall, electricity is the movement of charge. Charges are either positive or negative. Protons are positively charged, and electrons are negatively charged. When we speak of electricity, we speak of the movement of electrons carrying that negative charge. Amps measure how many of those charged particles are moving through the circuit or, more specifically, across the point that is being measured. That could change in different parts of the circuit.

Volts, amperes, and ohms are the measurement units of voltage, current, and resistance respectively. They have a specific and unalterable relationship. Voltage is the product of current and resistance. In other words, $V = I \times R$. V is voltage in volts, I is current in amps, and R is resistance in ohms. In this relationship, if you have high resistance, you need to increase the voltage to keep the current constant. If you want to keep the voltage constant, then you will have to reduce the current.

In the same way, $I = V / R$. It is the same thing just rearranged concerning I. In this case, to keep I constant, any changes in voltage must have an inverse change in resistance. So to keep amps constant, a higher resistance requires a higher voltage.

Resistance

In the same way $R = I / V$. In this case, to keep resistance constant, any increase in current must be accompanied by an increase in voltage. You just need to keep this relationship in mind. But there is one aspect of all this that can confuse many people. Voltage is typically fixed. You either live in a country that gets 110V or 220V out of the wall. You can’t change the voltage, so that is typically fixed. What you can change are amps and ohms. Amps are more about what is pulled rather than what is pushed. It's better to think of amps being pulled, volts doing the pushing, and resistance being stationary. Using these three states gives you an idea of how to control them. If you need more voltage, then change the number of batteries in a battery-driven system. In terms of amps, if you get a motor to go faster, it will pull the amps it needs to run the motor. That increased amp requires lower

resistance when the voltage remains the same. But since the wall outlet still has the same voltage, when you increase the amps what you realize is that the wires start to heat up. That is why fuses melt. The increased heat melts the filament and the circuit breaks. To reduce the resistance, you will have to increase the cable's size, which would reduce the resistance.

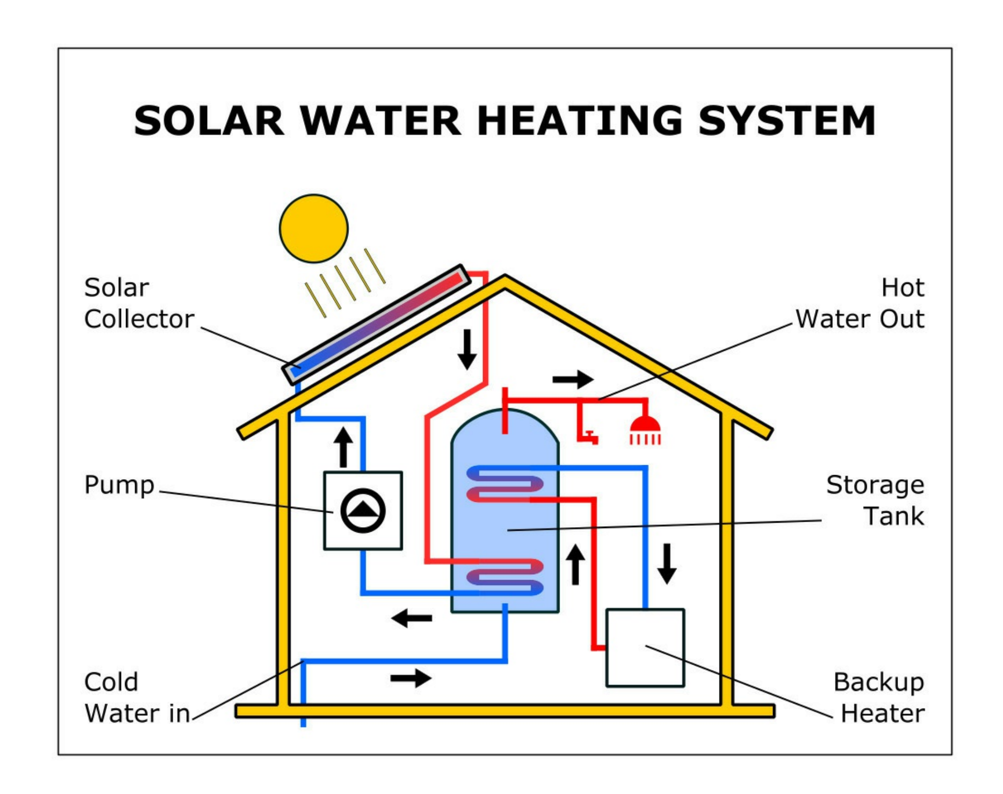
The greater the diameter of the cable, the less the resistance and the more current will be able to pass through it without it increasing in temperature.

Power

Power usually means something else when we use it in everyday conversations. In electricity, power has a specific meaning. Power is about the force that voltage and current create. Remember, the current is the number of charged particles that flow per unit time, and volt is the force that pushes the electrons. Power is the force and the quantity that results from certain volts and certain amps. 12 amps at 110 volts result in 1,320 watts. Power is voltage times current or volts times amps. A 110-watt light bulb on the 110-volt system means that it is drawing 1 amp. A 5-amp appliance on a 12-volt source will give you 60 watts. It's not that difficult to calculate wattage. Volts—amps—watts.



CHAPTER 5: EXAMPLES OF SOLAR POWER PROJECTS



Newly developed solar technologies allow us to perform water heating, space cooling, space cooling, and process heat generation.

WATER HEATING

Nowadays, we can use sunlight to heat water efficiently. Solar hot water systems make this possible. In places with low geographical latitudes, solar heating systems can provide 60% to 70% of domestic hot water use.

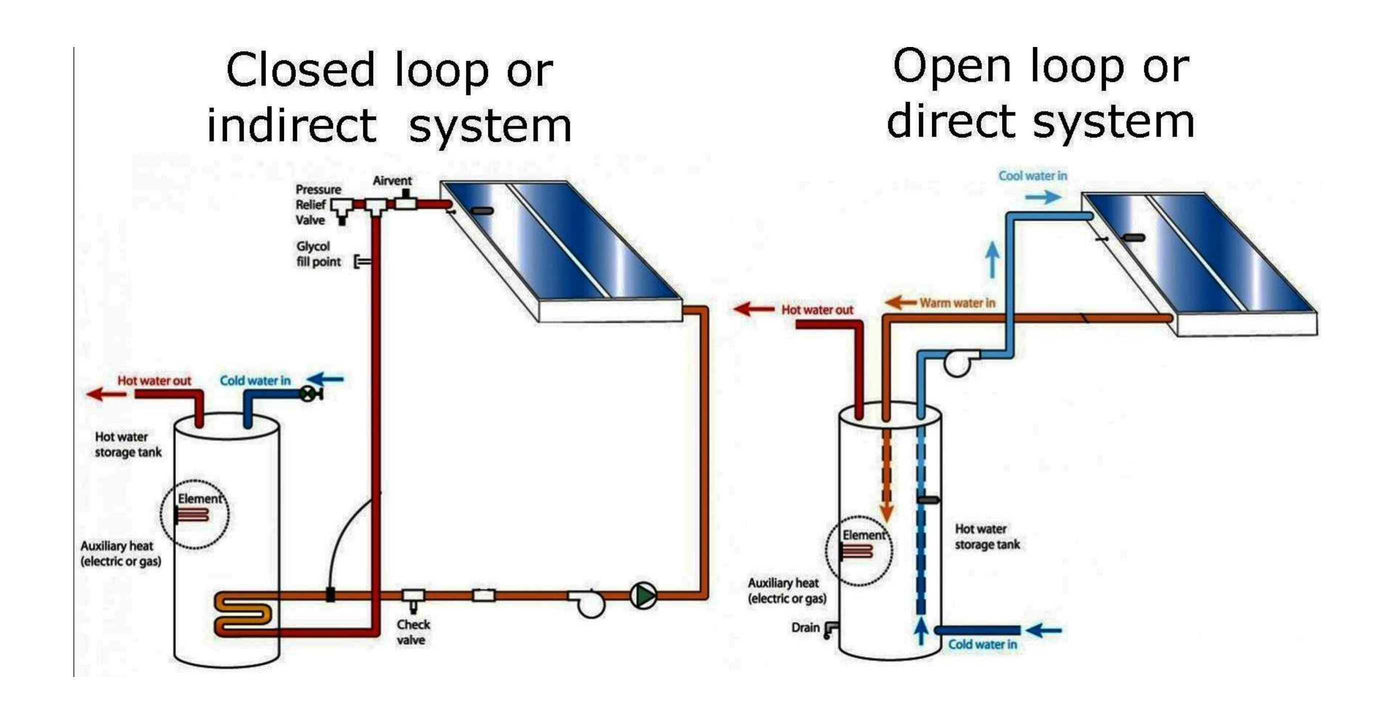
No more need to use electricity or fuel to make water hot! In these systems, water can be heated up to 60c. This isn’t exactly boiling point, but water at these temperatures is already comfortable and useful for warm baths and similar purposes.

Evacuated tube collectors and flat plate collectors are commonly used to generate hot water. These are mainly used to provide water for warm swimming pools.

The capacities of these solar hot water systems can be as much as 54 GW (thermal gigawatt). Among many countries that use solar technology, China is the world leader. They deploy up to 70GW of heat as of 2006.

This number is expected to increase further in the coming years. In Canada, United States, and Australia, heating systems for pools mainly use solar technology.

This shows that the efficiency in harnessing the sun's power for thermal purposes is nearly sustainable.
https://sustainability.stackexchange.com/questions/5126/failed-solar-thermal-water-heating-system



Closed loop or indirect system
Open loop or direct system
Pressure Relief Valve
Airvent
Glycol fill point
Hot water out
Cold water in
Hot water storage tank
Element
Auxiliary heat (electric or gas)
Check valve
Cool water in
Hot water out
Warm water in
Element
Hot water storage tank
Auxiliary heat (electric or gas)
Drain
Cold water in

HEATING, COOLING, AND VENTILATION

In developed countries, especially those with extreme climates, air conditioning, ventilation, and heating systems use so much energy.

They account for 30% of energy use in commercial establishments. In the domestic setting, the percentage is larger, hitting 50%. This is a very large amount of energy expenditure.

Nowadays, solar technologies are being used to lessen the burden of spending too much traditionally produced power.

The use of “thermal mass” makes these systems useful. A thermal mass is a material that is used to store heat from the sun.

These are naturally occurring, unlike materials in laboratory and power plants. Stone, cement, and water are commonly used as thermal mass. Previously, these materials have been used to make the climate more temperate and bearable.

Nowadays, however, they can be used to maintain warmth in very cold areas. These thermal masses maintain space temperature according to daylighting and shading conditions around the mass. When properly used, they can reduce the need for equipment for heating and cooling the temperature.

Have you heard about the solar chimney? This utilizes a form of solar ventilation. This system has a vertical shaft that connects the interior and exterior of an establishment.

When the chimney warms — due to solar energy — the air inside the solar chimney is heated up and pulls air throughout the building. When used alongside glazes and thermal mass materials, it is more effective. To some extent, this technology mimics greenhouses.

WATER TREATMENT

Saline or brackish water can be made potable using ***solar distillation***. How can sunlight make water potable? The key process here is water treatment.

In the 16th century, Arab alchemists were attempting this, but the appropriate process is only recently developed.

A solar distillation plant is very large, measuring up to 51,000 square feet. It can produce an amount of potable water in volumes of 227000 liters.

Imagine how much water this is! With well-developed water treatment technologies, we can find a way to eliminate thirst.

There are many individual designs for water treatment using sunlight. For domestic use, the double-slope stills are the most common.

A still is a kind of apparatus that purifies water by heating, selectively boiling, and cooling to condense the vapored water.

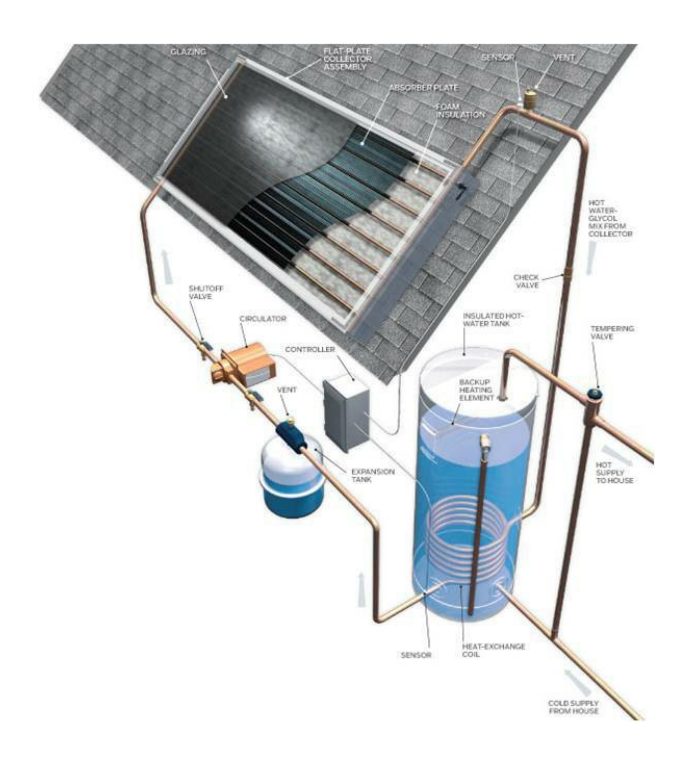
This apparatus is also being used in the production of perfume and medicine. Some stills have single-slope and double-slope designs. They operate in various modes depending on the volume of water involved and the intensity of heat generated from the sun.

For large-scale use, active units with multiple effects are still being used. They are also suitable for the production of potable water.

Using solar power, it is now also possible to disinfect water. Plastic bottles are filled with water. They are then exposed to the sun for several hours.

The heat of the sun disinfects the water and kills harmful bacteria. In times of disasters and countries with no potable water source, this method is being used by more than two million people.

https://www.appropedia.org/Solar_thermal_panels


GLAZING
FLAT-PLATE COLLECTOR ASSEMBLY
ABSORBER PLATE
FOAM INSULATION
SENSOR
VENT
HOT WATER-GLYCOL MIX FROM COLLECTOR
CHECK VALVE
SHUTOFF VALVE
CIRCULATOR
CONTROLLER
INSULATED HOT-WATER TANK
TEMPERING VALVE
BACKUP HEATING ELEMENT
VENT
EXPANSION TANK
HOT SUPPLY TO HOUSE
SENSOR
HEAT-EXCHANGE COIL
COLD SUPPLY FROM HOUSE

PROCESSING HEAT

Solar technologies are now also being used to provide processing heat. In the last chapter, you have read about concentrating solar power through lenses and mirrors.

This is also the same technology that is being adapted to provide and process heat for commercial applications. The parabolic dish, trough, and the Scheffler reflectors are some of the innovations that make this possible. Nowadays, we can say that heat production in these technologies is relatively efficient.

The first commercial system for processing heat through solar means is the Solar Total Energy Project.

This began in the United States. In the system, 114 parabolics composed the field. It provided up to 50% of the energy required for air conditioning, process heating, and electrical requirements of a clothing factory. Imagine how useful the investment in the equipment was!

This system had also been able to provide 400kW of electricity with the addition of thermal energy. It generated 468kW for chilled water and 401kW for steam. Imagine if industries all over the world could become this energy-efficient.

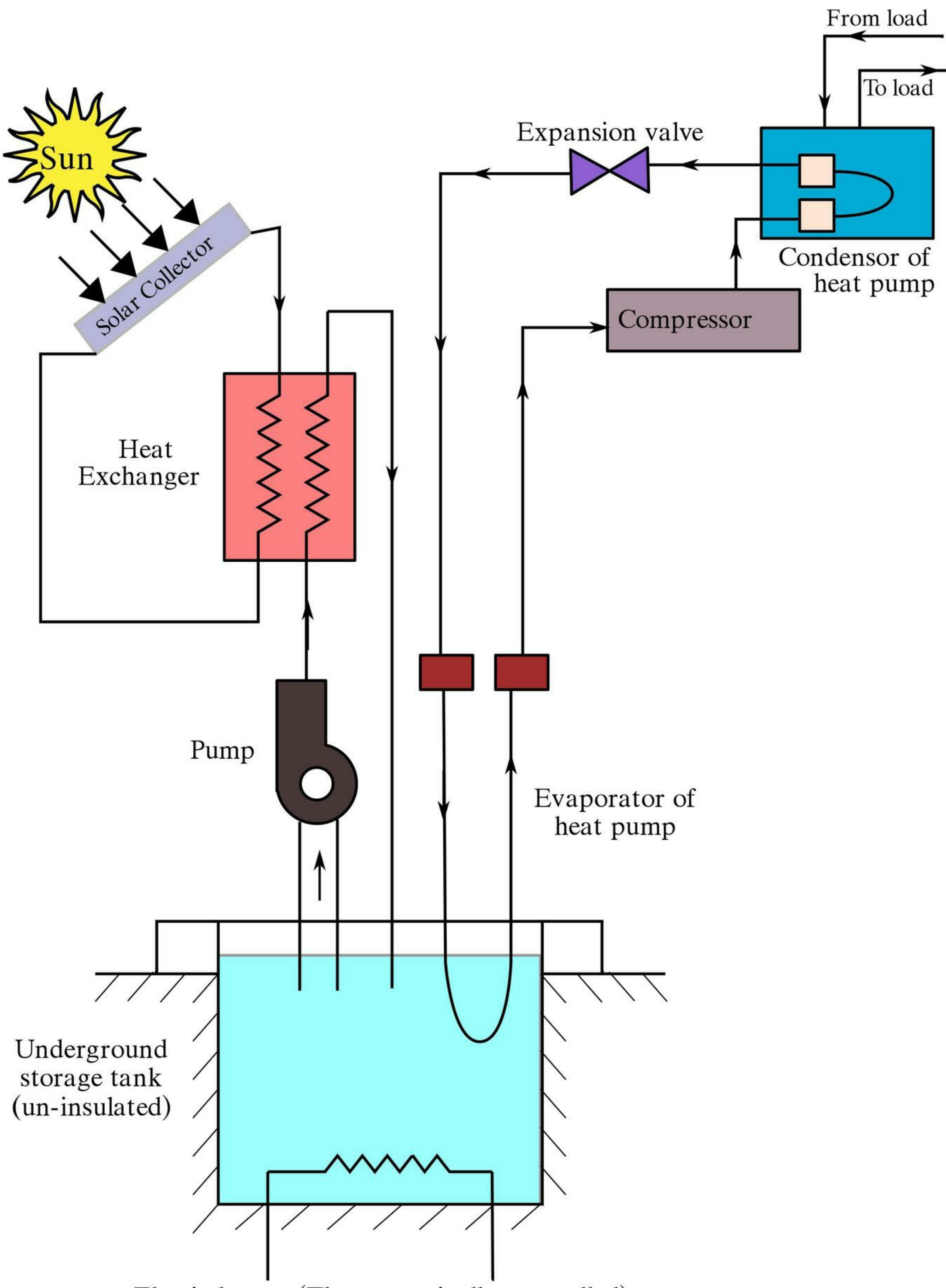
With lower costs for production, laborers can acquire better wages. This economic impact can be fully realized as solar technologies become further developed.

There are also such things as evaporation ponds nowadays. These are shallow pools that make use of evaporation to concentrate dissolved solids.

It allows people to obtain salt from sea water through the process of evaporation. In an environment-friendly pursuit, solar energy can also remove dissolved solids that have accumulated in waste streams.



https://commons.wikimedia.org/wiki/File:Series_Operated_Solar_Heat_Pump


From load
To load
Expansion valve
Sun
Solar Collector
Condensor of
heat pump
Compressor
Heat
Exchanger
Pump
Evaporator of
heat pump
Underground
storage tank
(un-insulated)
Electic heater (Thermostatically controlled)

COOKING

Do you make use of a rice cooker? The one that you have at RV probably needs electricity from a wall outlet to run. ***Solar cookers*** are being developed recently, and they could be used for drying, pasteurization, and – of course – cooking.

Solar cookers have three general categories: 1) panel cookers, 2) box cookers, and 3) reflector cookers. Each category has a different way of harnessing solar power and using it to power the solar cooker and perform its basic functions.

Box cookers, the most basic, have a container covered with insulators and a see-through lid.

These cookers work best on sunny days. Nevertheless, you can use also them during overcast weather, or when temperatures reach 194-302ºF. You simply put it under the sun and let solar energy do the job.

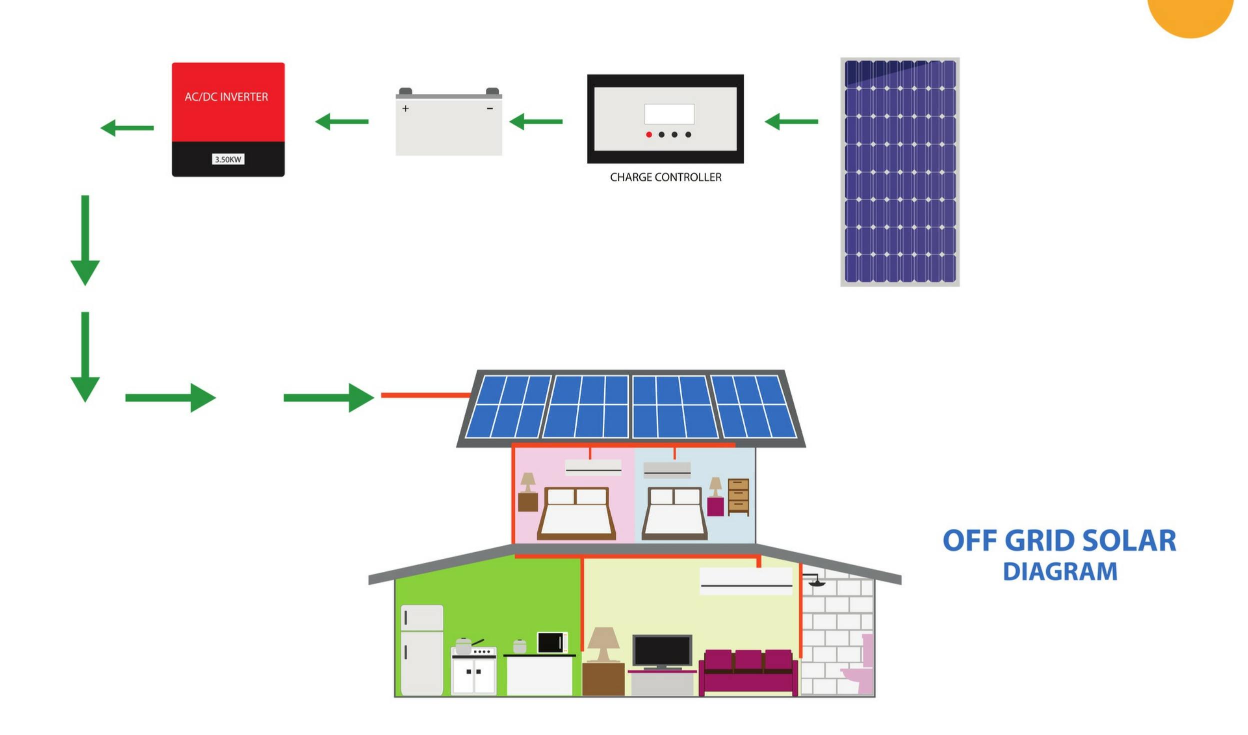
Panel cookers are a bit more sophisticated. They make use of panels that reflect sunlight (they are "reflective").

These panels direct solar energy to a container which is made with insulators. The amount of heat produced by these panels can vary according to the material and complexity of the design.

They reach temperatures that are similar to the most effective types of solar cookers.

Reflector cookers employ concentrating geometries on the other hand. They are a little more complicated to use since they require adequate light and proper positioning to keep track of the source of sunlight.

CHAPTER 6: DIFFERENCES BETWEEN OFF-GRID SOLAR & GRID-TIE SOLAR


AC/DC INVERTER
3.50KW
CHARGE CONTROLLER
OFF GRID SOLAR
DIAGRAM

WHAT IS OFF-GRID ENERGY?

The dictionary defines "off-grid" as not being connected to power lines such as water, electricity, gas, or oil and not using energy derived or manufactured by systems supplied by corporations. If you live in a remote house from utility services that derives its energy from the wind, the rain, or the sun, without oil, bottled gas, bottled water, or batteries, then you live off-grid. In many cases, off-grid life and self-sufficiency are the same things. E.g., if you gather your rainwater, you could be described as self-sufficient in water; if you possess your wind turbine, you’re self-sufficient in electricity.

WHY DO I STAY OFF-GRID?

For one of four reasons, most people set out on the off-grid route:

Many off-grid pioneers are inspired by what has come to be called "Pioneer Survivalism," meaning that they are driven by fears about some kind of disaster scenarios, such as food running out, contamination or toxins in our food and water, or climate catastrophe. Others opt for off-grid life because they believe the "hermit" approach is a good way to take control back. Off-gridders are often referred to as plug-pullers.

OFF-GRID ENERGY OPTIONS

Some of our off-grid wind turbines, hydro turbines, solar panels have their roots in on-grid technologies, and we have to embrace the fact that we start on an out-grid trip with some oil, waste, social and environmental debt, and then do our best to keep the debt down to a minimum. When Robert and Brenda Vale said in their book *The Autonomous House*, that there was no such thing as a fully self-sufficient home, they were right. A lot of the same goes for an off-grid home. We can work towards it, we can reduce our grid link-up, and we can reduce the impact of our carbon footprint, but we can never achieve 100% off-grid living.

<u>**Requirements Off-Grid**</u>

You will measure your "on-grid" energy consumption by summing up your household electrical meter readings over a 12-month cycle, adding up the cumulative kilowatt-hours (kWh) you used, dividing the number by 365 to give you the average per day, and then dividing the result by 24 to give you an amount per hour. It shows you how much energy you’d need to produce if you're off-grid, bringing the power output of wind turbines and photovoltaic cells into context. It is doubtful that you will produce all the energy you need, particularly if you are using an electric stove, washing machine, dryer, or dishwasher that needs much more power than can be produced or stored in batteries at RV using modern technology. In the time being, the solution is to produce as much additional energy as you can, seek to use less power, and find alternate solutions.

<u>**Off-Grid Energy Solutions**</u>

Electric power and heating energy can be produced on-site with renewable energy sources such as solar (especially photovoltaic), wind, or microhydro. Alternative sources of energy include biomass, usually in the form of coal, waste, and alcohol, and geothermal energy, making use of variations in

ambient temperatures in daily indoor air conditions in buildings.

POWER PANEL

In a standard solar system connected to the grid, alternating current is led from the solar inverter to the control panel, where it is routed to the various circuits and devices in the house. This is called ‘grid measurement,’ in which excess electricity generated by the solar system is fed into the grid via an energy meter or a battery storage system if you have a hybrid system. However, some countries use gross metering, in which all solar energy is exported to the electricity grid.

SYSTEM ON GRID

Unlike hybrid systems, grid-connected solar power systems cannot operate or generate electricity during a power outage for safety reasons and because power outages usually occur when the power grid is damaged; if the solar inverter still supplies electricity to a damaged grid, this would endanger the safety of the people who repair the grid faults. Most hybrid solar power systems with battery storage can automatically disconnect from the grid (the so-called island formation) and continue to supply electricity during a power outage.

If necessary, the batteries can be installed in networked systems later. Tesla Powerwall 2 is a popular AC battery system added to an existing solar power system.

In a network system, this happens after power has reached the panel:

The measuring device shows when excess solar energy flows through the meter, which calculates how much electricity is being exported or imported (purchased).

The electricity fed into the grid by your solar system can be used by other users of the grid (your neighbors). If your solar system is not in operation or you consume more electricity than that produced by your system, you will import or consume electricity from the grid.

OFF-GRID SYSTEM

Several off-grid systems will be covered in more detail later, but I will make it simple for the moment. This description applies to an AC coupled system. In a DC-coupled system, energy is first sent to the battery bank and then to the devices. To learn more about building an efficient off-grid house, visit our affiliate site, which is off-grid.

Simple, inexpensive, small, DC coupled, off-grid solar power systems use solar charge controllers to manage battery charge and a simple inverter to provide AC power.

There is no public power grid in a grid-independent system. As soon as the RV devices consume solar energy, excess electricity is sent to the battery bank. Once the battery is full, it is no longer powered by the solar power system. When the solar system is not working (at night or cloudy days), the devices consume energy from the batteries.

When the batteries are low and the weather is very cloudy, an emergency power source is usually needed, e.g., an emergency generator or a generator. The size of the generator set (measured in kVA) should be sufficient to power your RV and, at the same time, charge the batteries.

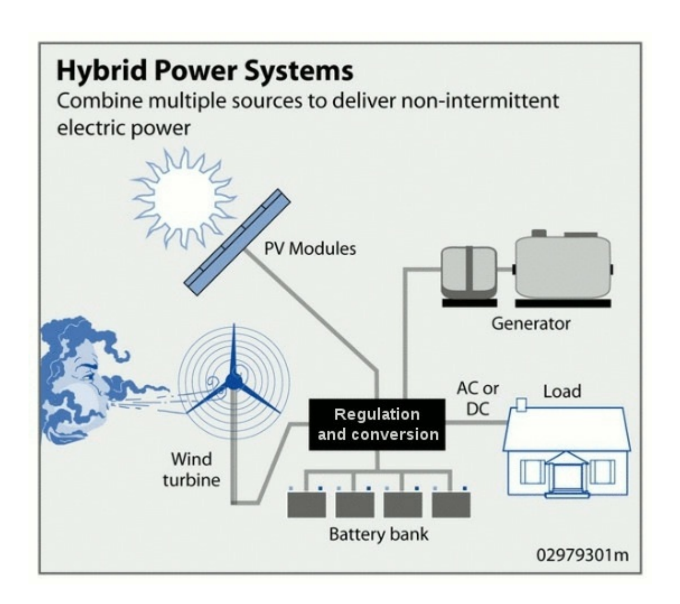
HYBRID SYSTEM

There are also several ways to design hybrid systems, but we’ll keep it simple for now. You can find more information on the various hybrid and off-grid power systems in our detailed guide to solar battery systems for private homes.

In a hybrid system, excess electricity is sent to the battery bank as soon as solar energy is used by the devices you own. As soon as the battery is fully charged, it no longer receives electricity from the solar power system. Battery energy can then be discharged and used to power your home, usually during the peak of the evening, when electricity costs are generally the highest.

Depending on how your hybrid system is installed and if your energy supplier allows it, the excess solar energy that is not required by your devices can be exported to the network via your meter after it has been fully charged. When your solar system isn't working and you've run out of usable electricity in your batteries, your devices draw electricity from the grid.

https://en.wikipedia.org/wiki/Solar_hybrid_power_systems


Hybrid Power Systems
Combine multiple sources to deliver non-intermittent electric power
PV Modules
Generator
Wind turbine
Regulation and conversion
AC or DC
Load
Battery bank
02979301m



CHAPTER 7: ASSESSING YOUR SITE

HOW TO SIZE A SOLAR SYSTEM – A STEP-BY-STEP WALKTHROUGH

After establishing that a grid-connected solar system is the best option for your home, we would like to help you properly size the system. This section will learn how to size a solar system that covers your energy consumption patterns without oversizing your photovoltaic system.

As a systems designer, I follow a step-by-step process to size systems based on the dimensions that work with my client's project constraints.

The first step is to discover the main constraints for the project and use these constraints as a starting point for the design. We can approach the project from one of three angles:

- Budget constraints: Create a system within the set budget.
- Space restrictions: Create a system as space-saving as possible.
- Energy offset: Create a system that balances a certain percentage of your energy consumption.

Some common obstacles that keep popping up:

- Local sunlight
- Array alignment (tilt angle)
- Plans for future expansions
- Evaluation of product efficiency
- Natural reduction in benefits during the warranty period

Considering the restrictions mentioned above, this section is intended to provide a detailed overview of the sizing process for grid-connected solar systems.

Sizing of photovoltaic systems connected to the grid: quick estimate**,**

First, determine the kilowatt-hour (kWh) consumption from the electricity bill. We would like to be available every 12 months to view the peaks and valleys used. Energy consumption increases in summer and winter when air conditioning and heating devices are used heavily. A whole year of data on energy consumption gives us the overview we need.

We would like to average the 12-month invoice data to determine the average monthly consumption of kWh. Networked systems tend to produce an excess in summer with maximum solar radiation.

If the service company offers a convenient guideline for net measurement, the system's energy can be registered with the service company as credit for later use. Not all utilities do this. Check with your local supplier.

Next, we would like to search for your sunshine hours per day using a sunshine hours chart or the PV watt calculator (I will come back to this in the next steps).

We can use this simple formula for a general estimate and then refine it as we move on to design:

(Annual kWh consumption ÷ 365 days ÷ average hours of sunshine) x efficiency 1.15 = size of the required solar DC system.

If the solar system cannot be exposed to the south at the preferred angle, it is necessary to adjust it by adding more solar energy.

Here is an example I live in New Mexico, where the photovoltaic watt calculator says I have an average of 6.10 hours of sunshine per day. It's a lot, I know, but that's why I live here. I use 1000 kWh per month or 12,000 kWh per year. According to the formula:

(12,000 kWh ÷ 365 days ÷ 6.1 hours of sunshine) x 1.15 = 6.2 kW DC solar system required

PROJECT DEVELOPMENT OF THE ESTIMATED SYSTEM

A roof bracket is a simplest and cheapest solution. It costs less than other racks. The roof pitch is often designed for solar gain and keeps the solar modules close to the inverter and the service panel. This is excellent for efficiency and costs less in pipes and wires.

If a roof bracket is out of the question, I will consider the possibility of floor mounting or a solution mounted on a pole.

As soon as we know how much space we have for the solar panels and the angles and directions we will work, I take the photovoltaic watt calculator and follow these steps.

HOW TO USE THE PVWATTS CALCULATOR

If you are on the System Information page, enter the size of the CC system from the previous section.

Select the standard module.

For the array type, select ‘fixed’ for the roof brackets or ‘open’ for the floor brackets.

Leave the system losses at around 15%.

Enter the roof slope in degrees and the azimuth. Azimuth is the degree of north and south, where north is zero and south is 180. (Click here to find out how to optimize the angle and azimuth values.)

After entering all the information, click the arrow on the right to see how much electricity your system uses each month.

This is our step-by-step process to refine a system of precise dimensions. We provide this information because our audience is very do-it-yourself, and most people prefer to do their research at their own pace.

Once you are ready, we advise you to organize a free design consultation with us to check the dimensions, find compatible products and make sure that the system works within your limits (budget, space, and energy offset). You can also call us at 1-800-472-1142 for immediate advice.

SELECTION OF SOLAR GRID SYSTEMS

Once we know how big the solar system must be, we will compare it to the available space. If you are doing a floor mount, this is usually not a problem.

From my example above, I know I need a 6.2 kW DC system. I can multiply that number by 1,000 to confirm that I need 6,200 watts of solar panels.

My fastest resource is to go to our grid-connected solar packets and scroll down until I see something in this area. If the customer expresses the desire to purchase panels made in America or needs certain functions such as monitoring individual panels, I consider these options.

Here are some viable options that I would consider. Note that imported panels are cheaper, so you get around 10% more production at the same price.

Mesh binding systems with panels made in America:

- 6.2 kW system with Mission 310 W solar modules and SolarEdge inverters/optimizers
- 6.2 kW system with Mission 310 W solar modules and Enphase IQ7 + micro inverter
- 6.2 kW system with Mission 310 W solar modules and SMA central inverters
- Grid systems with imported panels:
- 6.7 kW system with 335 W Astronergy solar modules and SolarEdge inverters/optimizers
- 6.7 kW system with 335 W Astronergy solar modules and Enphase IQ7 + micro inverter
- 6.7 kW system with 335 W Astronergy solar modules and SMA central inverters.



CHAPTER 8: BEYOND INSTALLATION

WAYS TO AVOID SHORT CIRCUITS

The result of a short circuit can be damage to equipment, electric shock, or even a fire. And if you don't take preventive measures against short circuits, you only increase the risk of these situations. Roman Electric recommends that all homeowners in Milwaukee practice short circuit prevention practice.

Check the Devices Before Use

As with electrical outlets, devices must also be checked before connecting them. Short circuits can also be caused by incorrect cables or circuits from the device itself. Check the device for the following signs before each use:

- Damaged cables, housings, or wires

- Several cracks in the device.
- The device has exposed circuits.
- If you apply one of these signs, we recommend that you dispose of the device or have it repaired by a specialist.

Perform Basic Circuit Breaker Maintenance

Your electrical system is protected against short circuits. These are its automatic switches. These components in the control panel are turned off when electrical currents are classified as unstable, each of which is connected to a different circuit. We recommend that you perform some basic maintenance on the circuit breaker to make sure they work.

Here are some tips:

- Check each circuit breaker for damage, cracks, or loose parts.
- Know which circuit controls each switch. It is recommended to use an automatic switch detector. Further information can be found here.

- Clean dirt or stains on the switch and panel (use only a dry cloth).
- If you wish to improve the maintenance of circuit breakers with professional services, contact Roman Electric to obtain our circuit breaker services.

MAINTAINING YOUR SOLAR SYSTEM

For some reason, it has entered the public's cumulative consciousness that most people can easily undertake solar power installation. This is certainly not true, and more importantly, this is dangerous. But as far as maintenance is concerned, there are a few things that one can do, but the rest of it should really be undertaken by a professional, as well.

Typically you should check with the installer if they have a service contract that you can sign up for. It typically involves a monthly fee that may be waived for the initial months if they performed the installation. It also makes it extremely unlikely that there will be any fuss in the event of a warranty claim since they are the ones doing the maintenance.

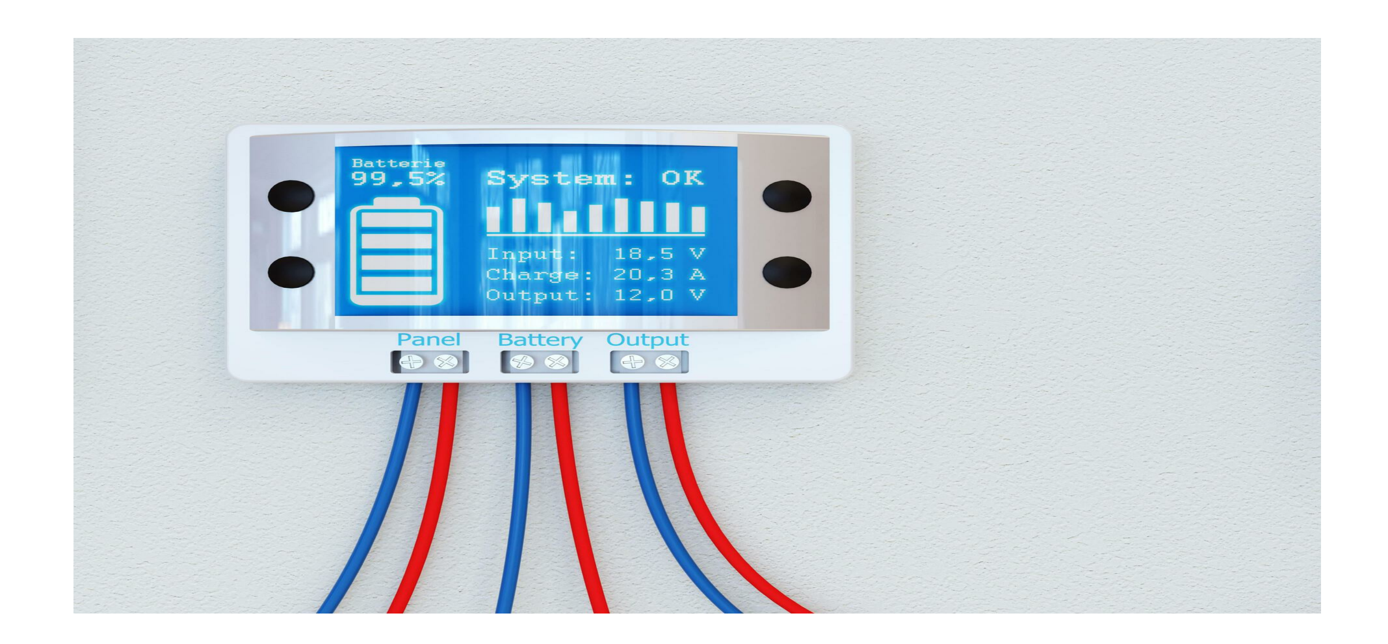
So the first best bet that you can make is signing on with your installer for a service contract. When you are choosing your installer, this is one of the things you should check on and negotiate.

If you really want to get in and get your hands dirty, you can either get a kit with detailed instructions and as long as you are handy with the necessary tools, then you should be fine. Just make sure you get a licensed electrician to at least do the wiring and give it a once over before you turn things on — especially if you are connecting it to the grid.

You should still get a professional to maintain it, but there are things that you can do to keep it in tip-top condition above and beyond what the service guy does. Make sure that the panels are always clean and the glass is in good condition. Wipe them clean and if possible, when you have them installed on your roof, install necessary walking up paths between the panels to give yourself room to clean the glass and perform upkeep maintenance.

Make sure there are no rodents in the areas where wiring runs and, if possible, run the wired in conduits and keep them out of exposure to the

elements and pests. Run the self-diagnostic tools if you have an automated system. Test all circuit breakers as well. Check the manual for your particular system and keep a checklist based on the items that they recommend as user maintenance.



CHAPTER 9: CHARGE CONTROLLER

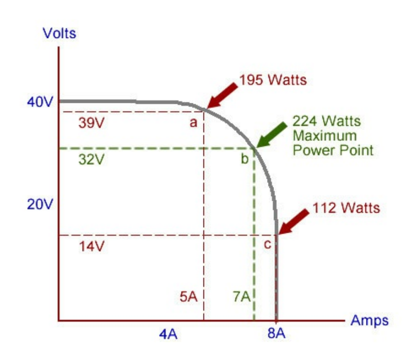
You need to use a solar charge controller to prevent your batteries from overcharging or over-discharging. There are times that your solar panels may charge the batteries more than you had planned for (like when you drive on a sunny day in snow-covered areas), and that extra current from the panels will degrade the batteries. To prevent that, you need to get a solar charge controller.

There are only two things you need to know to be able to make a selection. First, you need to know what voltage your system is designed for, is it 12, 24, or 48 volts? In this book, we have been looking at 12-volt systems. So, if you followed everything here, it would be a 12-volt charge controller. Some controllers auto-detect the voltage and adjust accordingly.

The second is the current that you will be looking at during peak charging. For this, you need to look at the solar panels you are purchasing. They will list peak charging in their manual. Look for what is called “short circuit

current.” Once you get that number, add a buffer to it. Let's say your panel's short circuit current is 8 amps; if you add a 25% buffer, that means you need to get a 10-amp solar charge controller.

https://electronics.stackexchange.com/questions/52916/current-amplifier-concept-in-solar-panel



RATING OF THE CHARGE CONTROLLER

When shopping for the charge controller itself, it is important to become familiar with the rating on the controller, that is, the technical specifications on it.

It is worth noting that all three types of controllers have the same characteristic though their individual characteristics will vary according to their type.

The determining factor you need on your solar charge controller will be the voltage of the batteries you are using and the maximum output current of the solar array.

So, if you are using 12-volt batteries, then your charge controller should be outfitted for the 12-volt batteries.

If you are using 24-volt batteries, but your controller is set for 12 volts, you will not power the batteries.

On the contrary, if your charge controller is set for 24 volts, but you have 12-volt batteries, you may end up delivering more voltage than specified for the batteries. This will lead to damage. So make sure that your charge controller matches the voltage on your batteries and also the voltage of a solar array you build.

That being said, you can buy an MPPT charge controller, which can regulate multiple voltage levels. That would certainly be of benefit to you, especially if you upgrade from lower-voltage batteries to higher-voltage ones or decide to rebuild your storage system.

The cold weather (low temperature) increases the voltage output of solar panels and you must count this when choosing a solar charge controller. The voltage may increase up to 25% if in the place where you live temperature falls up to -30 degrees of celsius. So you have to make sure that your solar

charge controller will handle this voltage input. It is always better to choose a bigger size solar charge controller for voltage increase, and just in case, you will decide to add more solar panels to your system.

If your solar charge controller should handle 100 volts, then you should choose at least 125 volts charge controller (25% more).

The other thing to consider is the amp rating of a solar charge controller. A good way to calculate the Amp rating of a solar charge controller that we will need as follows:

The Amp rating of a charge controller (I) equal solar panels array wattage divided by the voltage of the battery bank.

- I =P/V, Amps
- I – amp rating of the charge controller (amps);
- P – total solar panels array wattage (watts);
- V – voltage of the battery bank (volts);

For example:

The solar panel array power output is 400 Watts. The charge controller is reducing voltage to 14 volts for charging the batteries. So, 400 / 14 = 28.57 Amps. This means your charge controller should be equipped to handle a load of 30 Amperes or more.

30A x 1,25 = 37,5A (25% for low temperatures increase - to be safe)

So we should choose a charge controller that can handle 37,5 Amps. So we can choose and use safely at least a 40 amps charge controller.

If your charge controller is not equipped to handle a current such as this, then you run the risk of damaging the charge controller.

When you will be buying your solar charge controller to *check the maximum input voltage of the controller* if your solar panels are wired in series and have high voltage, typically maximum input voltage of a solar charge controller is between 50 to 150 volts.

I always make sure that the input voltage for the solar charge controller is at least 25% higher because I live in a place where the temperature can fall to -20 degrees of celsius.

A 100-watt panel in winter with low temperature can produce up to 120 watts

of power when the sun is shining, and I don’t want to damage the solar charger.

If in a place where you live, the temperature never falls below 0, then you can not expect such an increase in voltage or amps for a solar array.

WHICH ONE PRESENTS A BETTER CHOICE?

There are numerous reasons why anybody would want to decide on one and not the other and the contention can be made that it is beneficial to have the two alternatives in your framework.

Here is the thing however DC-coupled frameworks will, in general, be more financially savvy, and essentially along these lines, for little, homegrown independent frameworks. Air conditioning coupled frameworks brag of a similar cost-viability with regards to bigger frameworks. If your nearby planetary group is little estimated and just powers your home, think about the previous. In any case, if you mean to have a broader homegrown framework, the last is the better choice.

Charge controllers are essential components of solar panel systems, needed for several reasons. The brighter the sunlight you get, the more the voltage that will be produced and excessive voltage can damage your solar system batteries, hence you need charge controllers to control the amount of power getting to the batteries. Most charge controller units often include a 3-stage charging cycle that includes:

- The bulk: At this cycle, the voltage steadily rises to the highest level, especially between 14 and 14.6 volts, and the batteries are capable of drawing out the maximum current. The absorption phase will start once the bulk level of charging has been reached.
- The absorption phase: At this cycle, the Bulk voltage stage remains for a limited amount of time (about an hour), and the current lowers as the solar panel batteries absorb part of the current.
- The Floating phase: At this stage, the current is lowered to the floating stage after the batteries have absorbed their maximum level of current. In most cases, the volt levels at the floating phase

are between 13.3 and 13.7 volts.

The charge controller must be installed between the charging batteries and the solar panel arrays, and this arrangement ensures that charges in the battery are maintained at the three cycles explained above.

Note: Make sure you use a charge controller rated at 40 amps if you are using 250 Watt solar panels. The “Cloud effect” phenomenon created by a higher amp charge controller can increase your overall electricity output.

STEP-BY-STEP GENERAL INSTRUCTIONS TO INSTALL YOUR CHARGE CONTROLLERS

- The charge controller comes between the solar panel array and the battery
- Find a suitable location in the case that is easily accessible and have a box that you can close and latch. Run the wires from the combiner to this box and place the fuse box here.
- Install the solar charge control downstream from the fuses.
- Run the cables from the battery bank atop this box, place the fuses that come before the battery here, and connect the battery cables. It will also be where you will connect the generator leads later.
- Run the wires from the controller to the battery fuses.



CHAPTER 10: INVERTERS

The solar panel generates direct current or DC, but we need about 120 volts 60 Hz (or 230 volts, 50 Hz frequency if you live in Europe) AC electricity for powering appliances.

When electrical power generation became commercial at the beginning of the 20th century, power plants would produce vast amounts of DC power but quickly discovered that it couldn't be transmitted efficiently over long distances. This limited the coverage area that power plants had. In addition, the more power that plants were able to generate, the more that got lost in transmission.

Initially, this made electrical power unviable until Nikola Tesla discovered Alternate Current (AC). Eventually, Tesla's idea became commercially viable, and electrical power consumption spread widely around the globe.

Since then, virtually all appliances are powered by AC, as this is the type of energy that is used for residential customers. Moreover, smaller electronic devices such as cell phones and laptops run on DC. As such, cell phone and laptop chargers have a built-in converter that converts AC into DC so that these devices can run. Other types of batteries, such as the run-of-the-mill

Duracell and Energizer kind, also produce DC. The chemical reaction within the battery generates a given amount of voltage and current, which powers devices.

So, after a brief physics class and some history, you can see why the inverter is necessary.

One note: the system configuration which we presented way back in the first chapter, had a DC output section. In this case, you could use this DC output to power devices that run on DC. So, it is certainly worth having this option available.

TYPES OF SOLAR POWER INVERTERS

It is important to use an inverter that has been designed for solar power systems. It should be noted that the inverter receives its feed from the batteries. So, the panels charge the batteries through the charge controller, the batteries supply an inverter, and then the inverter converts DC electricity to AC. The current that goes from the inverter is what ends up reaching the outlets in your RV or vehicle. After this, you will be able to power your appliances.

The component of your solar power system that will be most likely to fail in the first 10 to 15 years is the solar power inverter. So, I would recommend choosing a solar power inverter that has the longest possible warranty even if it will be a little more expensive.

Off-grid inverters are inverters that aren’t connected to the grid and have battery storage.

On-grid or grid-tied inverters can be directly connected to the grid and solar panels and don’t require a storage system.

For domestic consumers, there are inverters from 800 to 10 000 watts.

Inverters also can be classified by voltage input the inverter accepts (12 volts, 24 volts, 48 volts, 96 volts) *DC power*.

In mobile solar power applications, such as for vehicles, the most commonly used are 12 volts DC inverters. For residential photovoltaic systems, the most commonly used are 48 volts inverters.

ADVANTAGES OF ON-GRID OR GRID-TIE INVERTERS

You can feed to the grid when the solar panels produce an extra amount of power and save extra money.

You can charge the batteries from the grid (the grid charger for the battery bank can be inbuilt in the inverter). When your batteries became drained and your solar panels can’t charge them then you can charge batteries by using power from the grid — provides smooth power to the load (hybrid inverters). An inverter can get power from either the battery bank or the grid when solar panels can’t deliver the load needed.

TYPES OF INVERTERS

String Inverters - Grid-Tied

Multiple strings of solar panels are connecting to one string inverter and then the inverter converts DC power to AC power; the most commonly used type of inverters. The best choice if strings of solar panels don't get any shading then the system can work efficiently.

This type of inverters is not designed for off-grid applications.

Central Inverters - Grid-Tied

Similar to string inverters but is larger and can connect more strings of solar panels; Strings are connecting to a combiner box which then runs DC power to the central inverter; This type of inverters is not designed for off-grid applications.

Power Optimizers

Devices are located on each panel. Instead of converting DC to AC as microinverters do, they optimize DC power and send it to a string inverter — designed to minimize the impact of shading on solar system performance and provides panel-level performance monitoring — can be more affordable than microinverters.

Battery Based Inverters (Off-Grid Inverters)

These inverters use battery storage to convert power. They are battery-powered and can be used in off-grid systems. Also, these inverters can be used in grid-tied and grid-interactive systems. This is the type of inverters that we will need to go off the grid or reduce dependence on a utility company.

Off-grid inverter can't sell produced power to the grid.

On the market is available inverters that have a built-in AC charger that can charge batteries from the grid if solar panels didn't charge batteries fully. But for off-grid inverters, AC connection is one-directional, they can only take

power from the grid and can’t send it back.

Also, you can connect a power generator to the AC input of these inverters, and you will be able to charge batteries this way. So you can use them in the winter or very cloudy days when your panels can't produce enough power.

It is great to have these options available, and it makes your system more flexible.

Some other features that battery-based inverters can have:

- Remote control (control inverter from the living room or via the internet)
- Display
- Inverter transfer switch
- Some investors can automatically use a generator or a grid AC load to help the invertor with high loads if the invertor can’t handle the load by using batteries
- Automatic generator start or AC charging (allows automatically start the generator and charge the battery when a charge is low and turning off the generator if they are charged)
- Stacking ability (inverters can be stacked to increase voltage and/or amps). Allows use of multiple inverters and automatically turn-on inverters as needed
- *Hybrid inverters (all in one grid-tie inverter)* or hybrid grid-tied inverters or battery-based inverters which combines a solar inverter and a battery inverter
- You can par solar panels with a hybrid inverter and it can function as both inverter for the battery bank and inverter for solar panels
- You can install hybrid inverters without batteries and add them later in the future.

So with these inverters, you can convert the power directly from the solar panels and consume the power with your appliances, and/or send it to the grid (or charge battery bank) used in stationary solar power systems.

Microinverters - Grid-Tie Inverters

Each panel has its own solar inverter that converts DC to AC. This helps to control each panel's performance and each panel is independent in the system. This invertor is not designed for off-grid applications.

These investors have higher efficiency, but they are more expensive to build the system.

Microinverters – 1 tiny inverter per panel.

Advantages

- All panels work independently, if one panel gets dirty or shaded - other panels will work just fine. If you will use a standard inverter and connect all panels in series, then if one panel gets shaded, all other panels stop working efficiently;
- Low voltage and amps (you don’t have to buy more expensive large wires when you connect wires in parallel, and amps will increase). Don’t have to worry that large voltage can cause you a fire;
- You can monitor each solar panel individually.

The big disadvantage of microinverters that it adds up from 15 to 20% to the cost of a solar system.

If you don’t want to install microinverters, then you can install a normal inverter and use *DC optimizers* for each panel to optimize them. Also, about a 15% increase in the cost of a solar power system.

HOW TO FIND A GOOD ONE?

You can search on google for top off-grid inverters and go on Amazon and find some pure sine wave investors with a high rating and positive reviews, and a good price. You will have to do some research here.



CHAPTER 11: HOW TO SELECT SOLAR POWER SYSTEM COMPONENTS

Let’s get a quick overview of the solar infrastructure in a remote platform. Sunlight hits the solar panel, and from there, current leaves the panel. At this point, it is DC current. That then goes to a charge controller and then on to the power bank, which is a string of batteries arranged in parallel formation. Since not all your equipment is going to run on DC, you need an inverter to convert DC to AC. At this point, you now have AC and DC power at the wall. Many of the appliances you buy will need AC, so along with the list of things you have planned, a diagram of where they will be installed is a good idea to know what electricity to channel to that location.

Now that you have the heart of your system set aside, it is time to look at how to choose your other components, including the solar panels, the charge controller, and the inverter. We will also look at choosing wires and generators for backup. The information is sufficient to get you on your way, but if you want more detail, you can refer to my other book, “*Solar Power:*

Making the Smart Switch to Solar Power—And Staying Within Budget!"

As with all things, there is a balance one has to strike when making a large-ticket purchase. There are numerous brands with multiple features for each of the compliments that we discuss in this section.

SELECTING SOLAR PANELS

There are two things you need to do to select solar panels. One is quantitative, the other is qualitative. The quantitative aspects are like how you calculated your power bank capacity.

There are three types of solar panels out there. Each of them has different cost, utility, and longevity profiles. You have to choose what's best for you. It is not always certain that the most expensive is the best for you in the same way that the cheapest is not always the most cost-effective. You need to look at the entire picture and see which ones give you the best return for your investment.

The basic element of a solar panel is silicon (not silicone). Silicon is represented by "Si" on the periodic table. It is basically what computer chips are made of, and it is the constituent of beach sand in its oxide form. It is an abundant element on the planet and has multiple electrical uses, one of which is solar cells.

The three types of solar panels are monocrystalline, polycrystalline, and amorphous (or also known as thin-film). Each kind has varying qualities and is not easily classified as best or worst. They are just different and built for different users with different budgets in mind.

It is pretty simple to distinguish one from the other. It's a pretty good bet that you have seen at least one, if not all, of them. The monocrystalline panels are the ones that you see that look like the corners have been cut off. In one panel, you have individual squares with their corner cut off, so if you look at the whole panel, it consists of a number of these arranged in rows and columns. The polycrystalline solar panels are visually distinguishable from their monocrystalline cousins. The entre panel is uniformly arranged so that it looks like a dark blue screen without the diamond-shaped tie structure that you see in the mono panels. Finally, the amorphous thin film is also

distinguishable from the other two because they are manufactured differently and placed on a substrate that can be either hard (like glass) or on something flexible that can be rolled.

Among the three, monocrystalline has the best efficiency (15% to 22%) and made from the highest grade of silicon, making them the most expensive in dollar terms. Because of their efficiency, you need smaller panels to get the same output as comparable panels made from poly or amorphous silicon. If you were to compare them side-by-side with amorphous panels, they would produce almost 400% greater output. Most manufacturers put a 25-year warranty on them because these panels can last that long. When you think of costs, you should amortize them to get a true reflection of your expense. Something that costs twice as much but lasts four times as long is certainly a better bet. But the thing to note here is that there are two downsides. One is obviously the cost—the initial outlay can be expensive. But, more importantly, the second downside is the nature of the electricity generation profile. Monocrystalline panels have a warm temperature range that produces at optimal levels. If it gets too hot, then the electricity generation starts to degrade. If you think that you will be out in summer on most holidays or be in hot climates and want to run an above-roof air-conditioning unit, maybe monos are not a good idea.

On the one hand, thin-film, or amorphous solar panels, is easily produced and cheaper than the other two kinds. They are significantly less efficient—with efficiency in the 4% to 8% range as opposed to mono, which comes in at more than 20%. But they cost significantly less, even after you consider you need five times the square footage compared to mono. The limiting factor is not so much the price, but whether you will be using it in hot temperatures. Thin film is impervious to excessive temperatures. You are also limited by the footprint—in this case, how much space you have on the roof of your RV or van.

When you pick a solar panel, calculate the square footage you have available and balance it with the power users that you hope to have. This is a zero-sum game. You can have an infinite amount of solar panels available to drive all the appliances you need. You will have to cut back on the appliances and power usage or get a bigger vehicle to supplement it.

SELECTING AN INVERTER

The next thing you need to get is an inverter. You need one specifically for RVs, boats, and vans. They have ones that go in RV PV setups, but you want to make sure you tell your salesman that you are putting this in an RV. The next thing is that your inverter has to work during two phases of use. The first is when you start something heavy, like an air-conditioning unit or a pump. That initial startup causes a surge and the peak demand is high, but only for a short time, then it reverts back to a stable consumption pattern. So you need to get an idea—and you can do this based on your list that we made in the earlier part of the book with all the appliances and the power usage. Remember that an inverter is there specifically for you to be able to run all your appliances that have AC because the current coming from your batteries is all DC.

SELECTING WIRE

Selecting the right wire is something that most people take for granted when setting up their system—be it their PV system at RV or on their boat, or even their hi-fi stereo. What they do not realize is that wiring is one of the most common ways to improve efficiency and to create a better overall PV system. The wrong wiring can not only reduce the efficiency of your system but could damage your appliance, or worse, be a fire hazard.

A good way to start is to have a diagram of your setup and then locate where your battery bank is going to be located. You need to look at the capacity of the solar panels and the distance the cables going from the solar array to the solar charge controller, and then the wiring that goes from there to the batteries. You also need cables to tie the batteries in a parallel arrangement. Afterward, measure the cables for DC power to the outlets that you think will have DC power, and then connect cables to go from the batteries to the inverter. From there again, you need to have wiring that goes from there to the outlets.

SELECTING BANK VOLTAGE MONITORS/POWER METERS

A battery monitor is an important part of the setup even though it is frequently misunderstood and not noticed. There are two things that the monitor does. One, it gives you a readout of the current state of your batteries, and two, it allows you to plan ahead to charge or discharge your battery. In most cases, battery monitors are not just voltage monitors. Voltage monitors are a good indicator of the state of the battery. Commonly, batteries will start to fade in voltage as they come to the limit of their useful charge. When the voltage starts to back off, you know that it is time to get it charged. Today, many of the monitors can be connected to a computer module that automatically runs the software to get your solar panels working and charging your system. Choose one that can hook up to a computer or get a readout directly on your smartphone via an app. In fact, if you can, you should be able to tie up all the individual parts of the PV system to an app that will allow you to control your RV remotely.

SELECTING BACKUP POWER

Backup power is not absolutely necessary. It depends on your profile—how you travel, where you go, and how often you stop at a marina for boats or at a place with electricity in the case. On the other hand, if you plan to boondock, you will need to have a generator for those times when the sun is not shining as bright or you used more than you intended to. Backup power is typically a generator. We will look at how we can choose a generator and what we need to look for when choosing a generator.

There are three kinds of generators to choose from: diesel, gasoline, and liquid propane. If you are concerned about burning clean, then your first option would be liquid propane, followed by diesel, and lastly, gasoline. But gasoline is easily available anywhere and everywhere. You can fill it up when you fill up your camper. Diesel is the next easily available and followed by propane that is not as easy to find. That is the second thing you want to think about: If you are the kind that keeps a generator just to back up for times when there is no sunlight and your use would be rare. Just remember that propane produces about 91,500BTU per gallon while gasoline produces over 125,000BTU per gallon. But gasoline can't be stored over long periods.

A camper class generator is what you need to look for. I am not aware of a rule, regulation, or law that says you have to get a camper generator for your vehicle, but it is a good way to go for several reasons, specifically because it has higher horsepower and is designed to be stowed as part of the camper with the proper venting all designed into it.

Just like the inverters, generators also have two ratings that you will want to keep in mind: the startup or peak power and the typical or constant power. In generator terms, they’re called startup wattage and running wattage. If you take a 30,00-watt generator, you can't assume that it has 3,000 watts of continuous running wattage—it's going to be startup wattage. That means it can give you a burst of 3,000 watts, but that is unsustainable for more than 10

or 15 minutes. To get an idea of what the running wattage is, you need to check the manual.

The next thing to determine when looking to buy a generator is noise output. You do not want to be a nuisance to yourself or your neighbors. The last thing anyone wants to hear after they've left a noisy city behind and come into nature is a loud generator pumping out noise and exhaust. Many campgrounds limit the noise to 60 decibels at 50 feet. Make sure you look for something that is at least at that level or better.

Another thing to consider is whether the generators are permanent or portable. Usually, if you have a large camper, then you are looking for a permanent fixture that is housed in a compartment that can be soundproofed and the exhaust can be ventilated up to the roof of the camper. If it is something portable, they are typically lighter and you can move them around. It comes in handy when you can store them in the cabin and then place them outside when running them.

In the first instance, when you place the generator in parallel with the batteries, your batteries go to the inverter and you get power from there at all times. The benefit of this is the simpler wiring, and it's a neat package. But if the batteries short out or are spoilt in any way, you will not be able to get power from your generators to your inverter without doing some rewiring. If you get good batteries, then this is not going to be a problem. You can also have a mechanical switch that moves the power directly to the circuit breakers and then onto the outlets, but that would end up costing more.

SOLAR ARRAY DISCONNECT SWITCH

There are two kinds of disconnect switches found in the market. You only need one of them. The other is for stationary systems that connect to the grid. The first is the solar array DC disconnect. This is the one that allows you to disengage the power coming from the solar array and going to the solar charge controller. You want to have this so that on days that you are not traveling or charging, the panels aren't continuously sending current to the batteries.

PV SELECTION

What photovoltaic means is it is a solar power system. However, there is a selection of photovoltaic systems out on the market and which one you choose depends on what you want to do when it comes to electricity. In this section, we'll go over the different photovoltaic selections so that you can pick one that is right for you.

Non-hybrid Integrated

The first selection is the non-hybrid integration method, and this means that you want to get off the electric grid entirely. There are some downsides to choosing this type of option. Some areas don't let you sustain an independent electric grid and many areas are currently in legal battles because they want to have this option. Non-hybrid means that you do not share your electricity with anybody else and you are no longer connected to the massive electric grid that your electric company provides. A lot of people who live in the desert or in the woods that don't have immediate access to the electric grid, and don't want to pay the connection costs for their property, prefer this non-hybrid integrated system. On the other hand, many people who don't want to deal with the electrical business anymore try to do this in cities where it's illegal to not be on the electrical grid. The way that the city usually finds out that a house is not on the electric grid is if the local power company reports that this person is no longer on their grid. The reason they want you to be on the grid is that the electricity provider takes the proper safety measures and has the proper certifications to prove that they know what they are doing, whereas the average individual DIY solar person does not.

Hybrid Integration

Hybrid integration is where you get the approval of the electrical company that you are paying to build your system into your house but also feed electricity back into the grid. Essentially, you build the same solar system layout, but this time you are allowed to feed electricity back into the grid. Hybrid integration is usually carried out by a company because of the necessary needs for certification and quality assurance and insurance. The

electric company doesn't know whether you are properly qualified to feed electricity back into the system without causing complications. Companies become certified in this so that they can provide the needed expertise to get the electrical company to approve of this.

Modular

The modular system is the most common type of solar power system on the market because it's the easiest to do by hobbyists and requires no certification to do it. It allows people who want to build the system themselves to create the system and put most of their electronics on the system without needing to gain the approval of the electric company. This means that you can take the power that's needed for all of your devices and put it on a grid that you built but you would still have the monthly charge of having a meter on your house for the electric company. Needless to say, you would still have to pay for any lights that are used inside of the house since those still run on the electrical grid owned by the electric company. However, most people make a modular system that doesn't require the use of these lighting systems in their house and so they generally just have to pay for renting the meter unit that's on the side of their house.

A Word of Warning

If you decide to make a non-hybrid integration without the proper certifications, you will make your house unsellable unless it is inspected by an electrician that has the certification for solar grid systems. Electric companies love to corner you with required certifications and approvals so that it is difficult to get off the electric grid. If you decide to put an electric grid into your house you run into a wall of certifications and approvals but, depending on how you do this, you could also run into damages. You see, the electric company has tried to pull a type of charge where if you make the system integrated on your house and you had to modify the line going through the meter to your house, then the electric company charges you for damages to their meter. As unjustified as this is, they have gotten away with it quite a few times.

CHAPTER 12: HOW TO INSTALL A SOLAR POWER SYSTEM

TYPES OF SUPPORTS FOR SOLAR PANELS

Photovoltaic modules are installed with brackets for solar panels. These brackets are available in 3 main types:

- Tree supports
- Brackets for attic
- Rinse the brackets

With the help of these brackets, you can install your solar panel on a camper, on the roof, or on the side of a pole on the roof. You can even install it as a standalone unit.

Things to do before installing the solar panel

COST CALCULATION

The first step is to calculate the cost of setting the type and size of the system. Keep in mind that the government of various countries around the world offers subsidies to promote renewable energy installation through solar panels. This subsidy is different in different countries. For example, the subsidies offered by the United States differ from those in India or China.

EQUIPMENT NEEDED

The second step is to create a checklist of devices needed for a solar system: solar modules, charge controllers, inverters, and batteries.

SYSTEM SIZE

The next step is to determine the size of the required solar system. You need to add the power of all the electrical devices you want to use. Calculate how many hours per day devices are used.

If you follow the previous steps, you can determine the power requirements, the required solar battery size, and the cable size. Remember that the correct cable sizes prevent overheating of the cables and ensure maximum energy transfer to the batteries.

SOLAR PANEL INSTALLATION MANUAL – STEP BY STEP

Install the Assembly

The first step is to repair the brackets that support the solar modules. Depending on the needs, these can be attic brackets or flush brackets. This basic structure offers support and robustness. Attention is paid to the direction in which the photovoltaic modules (monocrystalline or polycrystalline) are installed. The best direction for solar panels is the south for the countries of the Northern Hemisphere as they receive the highest sunlight. The east and west directions are also sufficient. For the countries of the southern hemisphere, the north is the best direction.

Here too, the assembly structure must be slightly inclined. The angle of inclination can be between 18 and 36 degrees to maximize conversion performance, many businesses use solar trackers.

Install the Solar Panels

The next step is the connection of the solar modules to the assembly structure. This is done by tightening screws and nuts. It takes care to adequately protect the entire structure so that it is robust and durable.

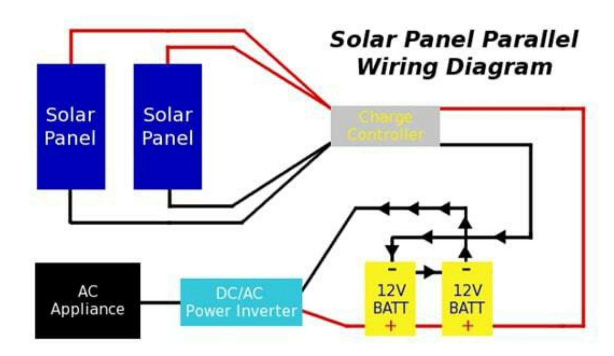
Make the Electrical Connections

Electric wiring is the next step. Wiring, common connectors like MC4 are used since they can be connected to all sorts of solar modules. The following sequence can be attached electrically to these panels:

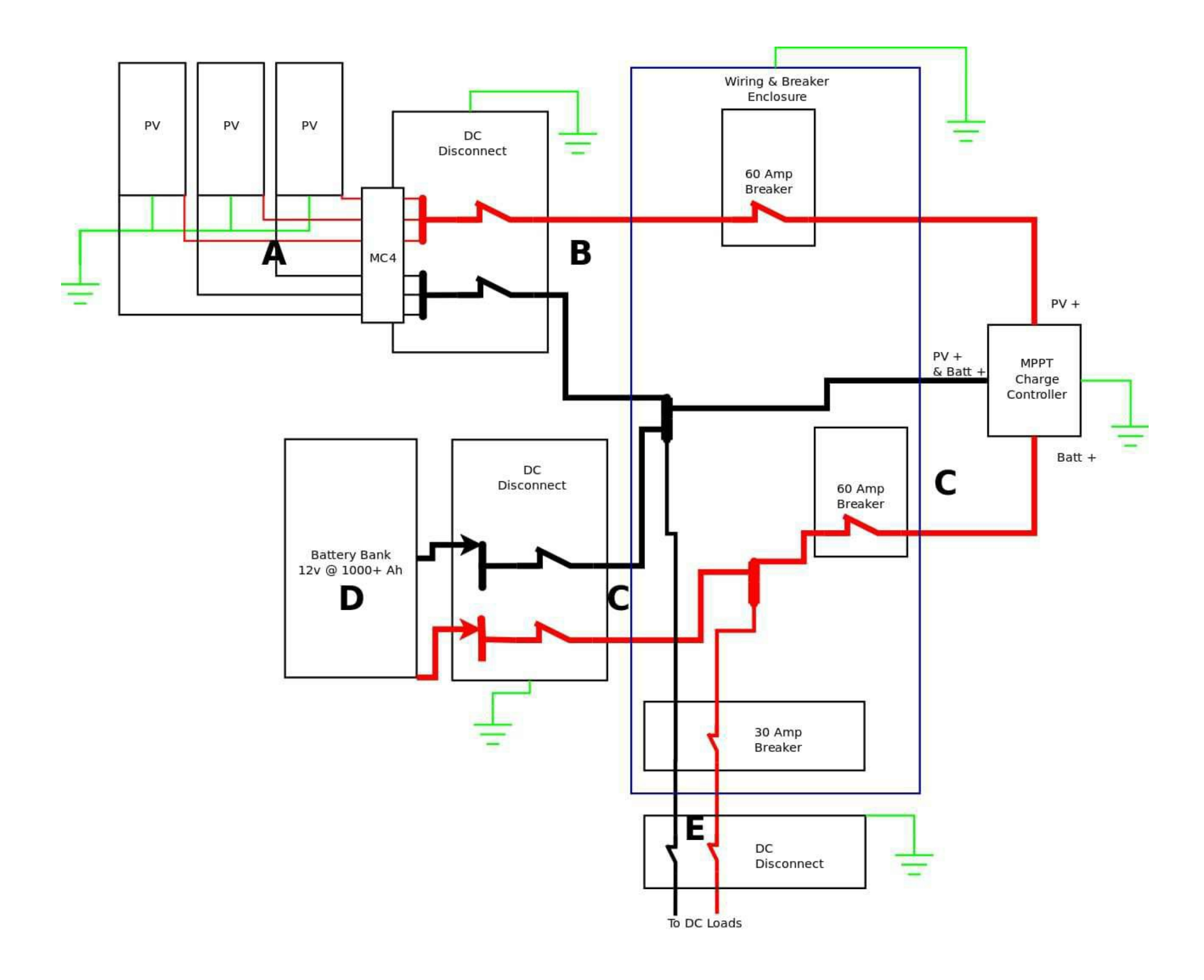
Sequence connection: In this case, one PV module's positive (+) wire is attached to the other module's negative (-) cable. This type of wiring increases the voltage regulation on the battery bank.

Parallel connection: In this case, a positive (+) to positive (+) and negative (-)

to negative (-) connection is established. This type of wiring voltage for each panel remains the same.
https://electronics.stackexchange.com/questions/213632/solar-panel-subsystem-project



http://hellohub.org/documentation/build-module-solar-power



Connect the System to the Solar Inverter

The next step is to connect the system to a solar inverter. The positive cable from the solar panel is connected to the positive pole of the inverter and the negative cable to the inverter's negative pole.

The solar inverter is then connected to the solar battery and the power supply to the grid.

Connect Solar Inverter and Solar Batteries

In the next step, the solar inverter and the solar panel are connected. The

positive pole of the battery is connected to the positive pole of the inverter and from minus to minus. A battery in the off-grid solar system is required to conserve emergency power.

Connect the Solar Inverter to the Electricity Grid

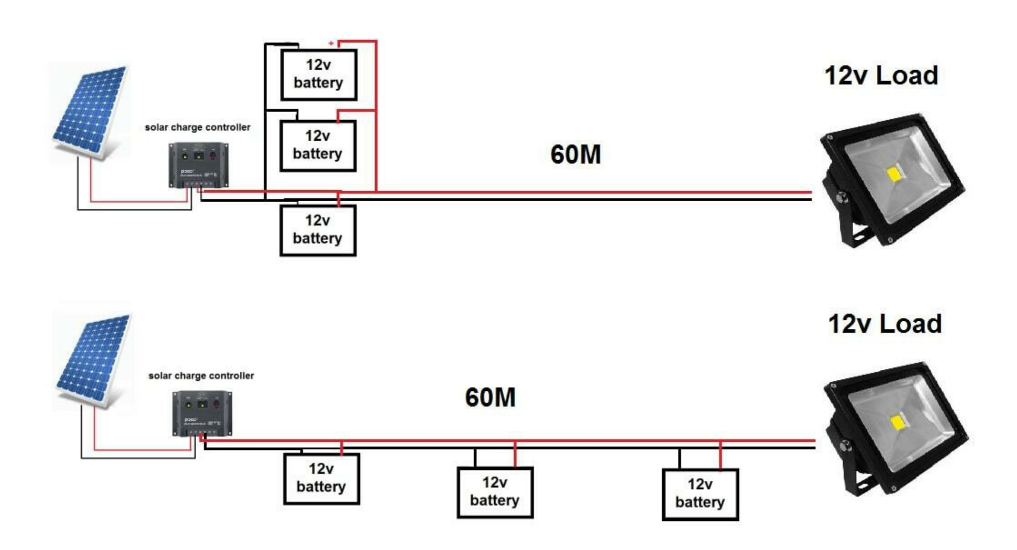
The next step is to connect the inverter to the grid. To make this connection, a normal socket is used to connect the main control panel. An output cable is connected to an electrical circuit that supplies electricity to the house.

Start Solar Inverter

When all the electrical connections have been made, it is time to start the inverter switch on the main switch of the house. Most solar inverters have digital displays that show statistics on the generation and use of solar systems.

TIPS TO ENSURE A SUCCESSFUL INSTALL

https://electronics.stackexchange.com/questions/222950/solving-problem-of-long-dc-wires



There is a distinct advantage to installing your own system which is even better than any financial savings you may make. This is that you will have designed the system and will know how it fits together and what to look at if any part may need to be replaced. This can be invaluable information if there is an issue with the system and it is not possible to contact assistance or to get anyone to help for a while. In fact, this concern relates directly to the reason why many people are considering either off-grid systems or battery backup ones. The increase in natural disasters has increased the number of power outages; having your own system will allow you to navigate these pitfalls with little disruption.

The following tips will help you to complete your install successfully:

Preparation

One of the most important factors in any project is planning before you start. Successful projects always need to be planned and to have a contingency plan. There are several key elements you should consider when devising your plan:

The average house can survive on a 3KW system that will take approximately twenty square meters of space; either on your roof or a ground-mounted install. Before purchasing any panels, you should measure the space you have available. Ideally, you should have a larger space than this and have the potential to expand your system in the future.

Fastenings are vital. Your choice of fastenings will depend upon where you intend to locate the panels and what your natural weather cycle is like. If you live in an area that is prone to cyclones or tornadoes you will need to ensure your fixing kit is likely to withstand a cyclone or tornado; you do not want your installation ripped apart right before you are most likely to need it.

There are different types of panels; although many of them now offer similar rates of power production, the panels you choose and even the inverter will affect the power generation and efficiency of the system. Whilst installing on a budget may attract you to the cheaper panels, you may find it more beneficial to choose fewer panels but have the higher quality ones. You can always add panels to your system.

Testing

There is no reason why you cannot test your system before you install it properly. Whilst the panels are relatively heavy, you can simply prop them up in your garden on a nice day and connect them up to either your battery bank or directly to your appliance. This can be especially useful if you are new to this type of install and wish to ensure you have understood all the parts of the system properly. This is also a good opportunity to test the equipment and confirm you have everything you need to install the entire system in one go. This can be a particularly useful exercise if you realize you have missed or forgotten one important part.

Information

Solar energy is still a rapidly growing and improving the industry. Things

that are the best possible today may not be the same tomorrow. It is important to stay abreast of the changes in technology as this will affect the prices of the current available solar panels or may even be worth waiting for if they offer significant advantages. Knowing the latest research and techniques should also make it easier for you to install your system.

Planning

You may notice a nearby house has solar panels; this does not mean that you will automatically have the right to put solar panels on your property. It is essential to check with your local planning department and, if necessary, submit an application. You may also find that erecting them is acceptable but that there are restrictions on the quantity or some other small clause. Knowing what the planning regulations are will ensure you do not fall foul of them and have to remove your install at a later date.

Space

You will almost certainly have considered the amount of space you will need to keep free for the solar panels. However, you may not have considered where the ancillary parts will go. The inverter and batteries, and the charge controller all need to be inside and relatively easy to access. You will also need to connect to your wiring. This may be as simple as running cables into the power supply of your fuse box or may necessitate some new wiring. Whichever path you need to take you will have to consider where the new wires are going; will they be fitted into the walls, out of sight? Knowing the space required and where you locate these items will make your installation process much easier.

Approval

If you are intending to install your system yourself but will be connecting to the grid you will need to gain approval from the utility company. Even if you can achieve solar power without touching the utility meter you may find yourself in trouble as you do not have permission to interact with the utility. To ensure your install is successful, it is advisable to contact the utility company first and find out what their requirements are. You can then ensure you comply with them; this will ensure your new system is a success and has the potential to supply you with free power for the foreseeable future.

You are likely to find a dedicated section on their website, allowing you to access the information regarding their requirements and even complete a

form to get the paperwork side of the installation finished as early as possible.

Installing your own solar energy system is more than just possible; it is actually fairly easy to do! All you need to do is a little preparation and have some patience whilst you design the system and ensure you have complied with all the relevant legalities.



CHAPTER 13: HOW TO WIRE UP YOUR SOLAR POWER SYSTEM

The first item to consider is the dimensions of the panels themselves. In essence, the greater the capacity on the panels, the larger the size. This relates specifically to the number of cells contained in the panel. Thus, more cells mean more surface to capture sunlight.

Of course, given the dimensions of the panels themselves, they may be too big or too heavy for your roof. This is something that you might want to get a second opinion. In this case, the last thing you want to do is put additional weight on your roof.

Roof mounting may not be the best course of action if you have an older roof that’s not in the best of shape. However, roof mounting may be your best choice especially if you don’t have much land on which to mount your panels.

You could have smaller panels though having multiple panels may be more

of a hassle than a benefit. Also, if you choose to mount your panels on the ground, make sure that they are in a spot where they can get direct sunlight most of the day. Before actually mounting them, monitor the area in which you would like to mount your panels to see if there isn't any shading.

Typically solar panels are about 65x39 inches or 165x100 cm depending on the manufacturer and power rating of a panel you will decide to buy.

By having the watt rating and dimension of one solar panel, you will see the number of panels you can install in a certain area.

WIRING OF SOLAR PANELS

Wiring in series (chain):

The negative lead from the terminal of 1 panel goes to the positive lead of another, then the negative lead of this panel to the positive lead of the third panel, and so on.

$V=V1+V2+V3+V4+\ldots$

$I=I1=I2=i3=I4$

The voltage will increase and amps will be the same. When we have small amps, we can choose thinner wire (because the thickness of the wire depends on amps going through the wire), and we can have smaller power losses.

CONS OF CONNECTING SOLAR PANELS IN SERIES

Solar panels are all connected and work as 1 giant solar panel. If 1 panel of the solar array will be covered by the sun, the efficiency of the hall solar array will be significantly decreased.

They should be all the same characteristics (volts, amps, material…) and be mounted close one to another and angled in the same way to work efficiently.

Wiring in parallel

In this case, the voltage will stay the same, but amps will add up.

$I = I1 + I2 + I3 + I4$

$V = V1 = V2 = V3 = V4$

Cons:

- Increased amps will require a thicker and more expensive wire to conduct electricity efficiently

Pros:

- Panels can have different amp ratings (but the same voltage).
- All solar panels in an array work independently. If one solar panel stop working other panels will steel keep producing electricity well.

COMBINED WIRING

You can wire 2 or 3 solar panels in series, then wire another 2 or 3 solar panels in series, and wire two series groups (strings) in parallel.

For example, if you have shading problems, you have installed a solar power system on a vehicle and you are traveling (you might park your vehicle in places where sunlight will be shading partially on your roof) in this case efficiency of your system will be lower. But if you will combine solar panels in a series by groups and then wire them in parallel efficiency of the system will be higher when part of your roof will be shaded.

Use MC4 branch connectors to wire in parallel multiple in series groups to make 2 or more wires of the same polarity in 1 wire. When you wiring a lot of solar panels together use zip ties to tidy up cables.

WHICH WAY TO FACE

The sun moves along the equator, there is a predictable pattern in which sunlight will travel. Besides, the curvature of the Earth will not distribute sunlight evenly. Sunlight will be distributed in a specific direction, given your geographical location.

For instance, if you live in the northern hemisphere, then your panels should face south. If you live in the southern hemisphere, then your panels should face north. Unless you are living in the exact equator, you can simply put your panels at 10-15 degrees on the ground to make sure the rain will clean panels. The sun on the equator is high all year.

If you are unsure which direction is north and south, you can look at a map tool such as Google Maps or use your car's GPS. Those are two very simple ways in which you can determine your north/south position. Or you can use a compass.

CONCLUSION

Solar energy remains one of the best and comfortable ways to power our homes. Despite the inconveniences, the use of solar energy has increased by about 20 percent per year in the last 15 years, thanks to the rapid fall in prices and the increase in efficiency.

It is an excellent alternative to cover and complement the energy needs of small cities or homes, today it is impractical when using this technology as the main source of household energy, but it is a great option to use as a complement.

If you are a person committed to the environment, this type of renewable energy is undoubtedly the best option to take care of the environment; it is clean, renewable, and does not harm the environment.

It is important not to underestimate the feeling of satisfaction you will get when you connect your own RV up to your own system and are officially no longer part of the grid. This is an achievable aim by anyone, even if you do not currently have the funds available. Simply apply patience and a disciplined approach and you will be able to buy your installation one piece at a time. The knowledge you have gained will ensure you are capable of fitting the system no matter where in the world you are located. This book should have provided you with all the information you need to establish a plan and get started with producing your electricity at home. Installing and operating your own energy system will reduce your financial commitments and enable you to spend more time enjoying life, safe in the knowledge that you are making a difference in the world.

BOOK 2



INTRODUCTION

The technology has continued to develop with a massive increase in interest at the end of the twentieth century, including the creation of a solar-powered aircraft!

Fast forward to the present day and you will find many houses with solar panels on their roofs and the ability to power their own electrical needs. Whilst these have been and will continue to be refined and improved, the basic principle remains the same. There is likely a big future for solar electricity and now may be the best time to purchase your own kit and install it to create your own electricity supply.

The world that we live in today does not resemble the one that we grew up in. My childhood was full of rich experiences involving playing outside in the dirt, eating food that was grown from our backyard, and using my hands to create, learn, and serve others. However, society has drastically changed since then. Nowadays, we live in communities controlled by a consumerist agenda where we are encouraged to consume more than we need. As a result of this culture of consumption, many people are deep in debt and cannot find peace from this lifestyle. Furthermore, the promotion of consumption has led to saddening levels of pollution caused by the greed of industries, whose only

mission is to make more and give less.

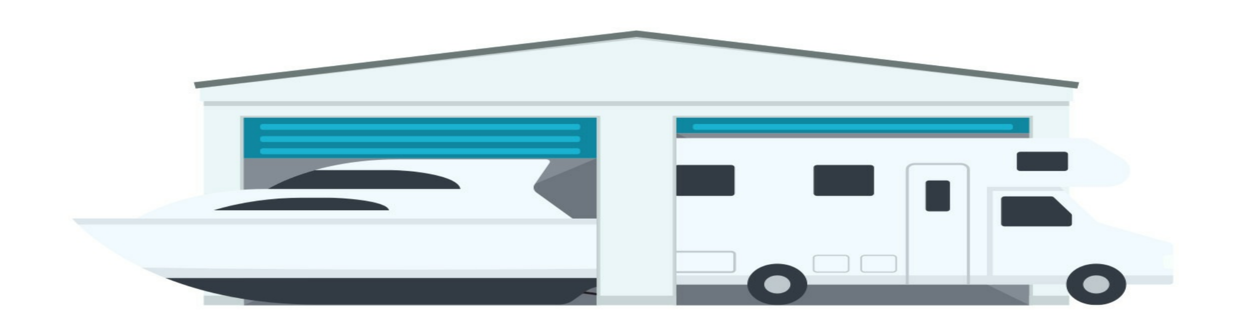
Our environment is crying out for the life of yesteryear, an existence that did not require so much human intervention and nature to provide for our needs. More than ever, we see people who share the same cries and desire to go back to the basics. A life spent living away from the concrete jungle and immersed in the beauty of our natural surroundings is beginning to appeal to many. Some have gone as far as living in remote locations where they are independent of any government support or intervention. We call this kind of lifestyle an “off-grid” or off the grid lifestyle because essentially, the individual cannot be pin-pointed on a map. They are not connected to any governmental power utilities where they can be sent a bill at the end of the month for the service.

A good way to categorize your wiring is to keep them in zones. This will allow you to troubleshoot inoperative components when the time comes. Designing electrical systems is about emergent situations. Everything that you do when you design and install them is about keeping it safe in case of a fault. Never design your system thinking that it will be faultless.

PV systems are designed to cater to most of your power needs, but they may not be able to take on all of it. You will have to supplement it in one way or another. If you have to park at a campground with services, you can get your batteries charged there or have a generator that supplements the power you need.

As the technology grows further, you can upgrade your power system and attain more effectiveness and efficiency. This opportunity is not available with traditional grid energy.

CHAPTER 1: A QUICK INTRODUCTION



RVS AND SOLAR BOATS

To get as near carrying on with a sound life as an RV lover as could reasonably be expected, you should have power in the RV. The equivalent applies to boats. While a few unconventionality like to drag generators around in their RV, a great many people with sense realize that sunlight-based boards are the best approach. However long the establishment is done capability and you don't stop your RV in the shade constantly, sunlight-based boards give you all the force that you require. This part covers the most fundamental components, to the extent RV and sunlight-based boat boards go.

DIFFERENT KINDS OF RV AND BOAT SOLAR PANELS

There are 3-board types for you to browse on the off chance that you are the pleased proprietor of an RV or sunlight based boat:

Mono-Crystalline Panel

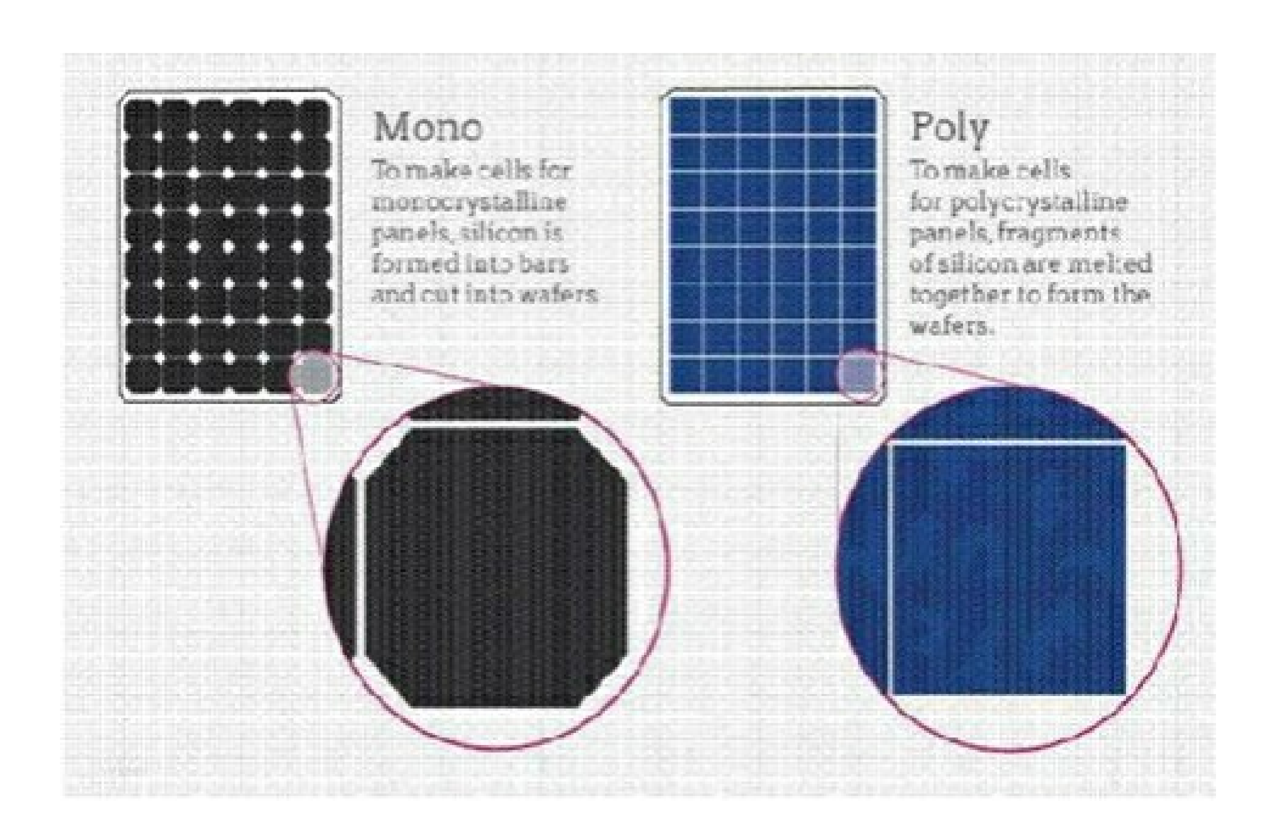
These boards are produced using a solitary gem. The individual cell on this board is a skinny gem of silicon.

Poly-Crystalline

Sun-oriented boards have a few little estimated gems.

Amorphous

These boards are slim boards of film. The cells are made out of a meager silicon layer and fix to the sponsorship material.


Mono
To make cells for
monocrystalline
panels, silicon is
formed into bars
and cut into wafers.
Poly
To make cells
for polycrystalline
panels, fragments
of silicon are melted
together to form the
wafers.

WHAT IS THE BEST RV OR BOAT PANEL FOR YOU?

The shrewd RV/boat proprietor views his rooftop like it were amazing property meriting simply the most ideal sort of board for it. Also, there is something else entirely to this than the straightforward idea of that sentence recommends. Let us look at all 3 choices:

- Shapeless boards are your least expensive alternative, and the productivity is amazing. The disadvantage is that it is multiple times the size of the polycrystalline board.
- The mono-glasslike translucent flaunts amazing proficiency and has been said to create more force in low light conditions than the other two board types.
- The poly-glasslike board, by a significant edge, is the most well-known board. It is half as little as the formless board, and keeping in mind that it doesn't pack the force punch that the mono-translucent does, it just delivers somewhat less force. On the off chance that this book is to make a board suggestion for you, the poly-translucent board is your most ideal alternative if you need a close ideal marriage of effectiveness and size. Nonetheless, this board is more costly.

Flexible panels for the RV – What is the difference between flexible RV panels & rigid solar panels?

FLEXIBLE SOLAR PANELS

This is the most recent sun-oriented innovation. A few people like to call them "slim film boards" that must be alright thinking about correctly what you consider them once you look at one.

Advantages

They are light-particularly along these lines, really, and you can stack a great deal of them on your boat or RV rooftop without being worried about the possibility that the C.O.G of your vehicle gets raised something over the top.

You can introduce these boards straightforwardly on the RV rooftop because of their meager and lightweight nature, which permits a more smoothed-out structure for your RV or boat. Likewise, the entire arrangement winds up looking stylish without a doubt.

Disadvantages

The section above says that you can introduce them legitimately on your rooftop. If you do choose to introduce them straightforwardly on the RV rooftop, at that point you would need to stroll on them eventually. The adaptable sun-powered board producers like to reveal to you that no damage will be done from strolling on the sunlight-based board yet in truth, they will inevitably create minuscule breaks that will influence the yield and cut the board life expectancy.

These sun-based boards accompany a 10-year guarantee. Is it safe to say that you are dazzled? Well, on the off chance that you will be, you truly shouldn't be. Their partners accompany 30-year guarantees.

Warmth development is consistently a factor with sun-based boards. The more space you have between the suns oriented board and the rooftop, the cooler the boards will remain. This will empower them to create the greatest force as conditions will be near ideal. Adaptable boards are fixed to your rooftop, and warmth development will go directly into the rooftop inside. During cold weather months, this can significantly affect power creation.

You may be content with less force creation in the late spring months.

The establishment of your adaptable boards will imply that you stick them to your rooftop. It isn't so difficult to stick them onto the rooftop, yet you will struggle to take them off the RV or boat rooftop once you choose to change vehicles.

RIGID RV SOLAR PANELS

These boards are hard, and they are typically fixed immovably. Their development is one of the glass sheets inside an aluminum outline. They are definitely more traditional than their adaptable partners.

Advantages

We will begin with the most evident one: these boards are unquestionably sturdier. They can take numerous beatings that accompany RV or boat travel. If you are hoping to claim your RV or sun-powered boat for quite a while, these will be ideal.

If you are the sort that is cognizant about the climate, silicon, the material the sunlight-based cells of these boards are made of, is all the more benevolent to the climate and stances fewer issues when removal/reusing opportunity arrives.

These boards have amazing warmth opposition. Additionally, similarly, as we stated, the more space there is between the board and the rooftop, the cooler the board can remain, amplifying power yield.

Disadvantages

They gauge significantly more than the adaptable ones

They do stand out over your rooftop and perhaps a blemish if you are into style.

By the day's end, glass is weak. The boards are made to withstand unforgiving climatic conditions, sufficiently sure, however, this reality actually stands.

What number of sun-oriented boards do you require for your RV?

Boards come in fluctuated watt sizes. Contingent upon the size of your RV or boat space, on the off chance that you can't fix one major sun-powered board, you have the choice of getting two boards with similar wattage. For instance, on the off chance that you have determined that a 120-watt board will well

deal with your capacity needs, you can get one 120 watt board or two 60 watt boards.



CHAPTER 2: CALCULUS

To calculate the exergetic proportion of thermal energy, consider whether the heat source has a constant temperature, such as in a boiling water reactor which stays at approximately 270 ° C, whether or not the heat output of its cooling medium flue gas takes place. The exergetic component can be determined via The relationship can likewise be seen on the charts: T the outright temperature in K; S the entropy in J/K; H the enthalpy in J file 1: beginning state list; and U: surrounding state.

The enthalpy distinction is basically (in this situation) the energy provided as the heat from the burning air fuel. It shows up as a territory under the isobaric heat gracefully bends. The exergetic part is over the encompassing temperature, the other non-usable part, called "energy," is underneath this line. The reduction in exergy in an energy transformation bind is likewise alluded to as energy downgrading.

When the heat is moved from the vent gas to the working medium, the water that vanishes and overheats, there is a further loss of exergy. For a procedure with superheated steam of 16 bar and 350 ° C, for instance, the greatest mechanical force that can be gotten from the steam mass stream should never be determined to utilize the Carnot productivity at this temperature. The

outcome with an effectiveness of 52% would not be right. It would negate the second law because the mean temperature of the heat contribution to the water-steam cycle is lower. There is no inward heat move from gathering steam to the feed water, for example, in steam motors. In the best case hypothetically, the steam can be reversibly brought to water with encompassing conditions. The greatest effectiveness of 34.4% is accomplished at a surrounding temperature of 15 ° C. Interestingly, the reversible Clausius-Rankine process in Figure 4 with a steam weight of 32 bar and buildup at 24 ° C arrives at 37.2%. With these steam boundaries, genuine procedures just accomplish far lower efficiencies.

RVS AND CAMPERS

Solar energy is the ultimate solution for campers and RVs. They provide necessary energy consumption to ensure power to your lights and other devices; however, there are multiple factors you should always remember when calculating energy consumption and the size of solar panels for camping purposes.

https://flickr.com/photos/afresh1/3818830911



The Output Provided by a Solar Panel

Become aware of the output that your solar panel can offer for your RV. This will help you know the energy budget, as well as the time associated with energy availability.

https://www.flickr.com/photos/stephanridgway/5388987683/



Geographic Location

You will have to take your geographical location into account too, as campers keep on changing locations. You need to calculate energy availability according to the sunlight availability in locations where you plan to go.

Devices You Have in Your RV

Air conditioners, lights, and many other devices require different power. On average, you can obtain a solar kit for your RV that offers 380-watt power to run general devices; however, the size will increase depending on what kind of devices you have in your RV. Similarly, you also have to care about the potential period for which you desire to use your devices in the RV.

Apart from that, make sure you include battery capacity in amp-hours to understand consumption. Large loads require a higher storage capacity to run smoothly.

Now, you can take the amp-hour of a battery and multiply it with the solar power capacity according to the time of sunlight, and then match it with the energy required to run your RV devices for a particular period every day. When these two numbers match, you will find the perfect size of panels for your needs.

CAN MY ROOF HANDLE IT?

The first thing we will look at is if your roof can handle the weight of the solar panels you are planning on installing. If you have a heavier solar panel—in the event you want to have a frame to angle the panels—the weight could start to add up quickly. If you add a motor to raise the panels into an incline remotely, that will increase the weight even more. Don't forget that you may also have planned on a rooftop box air-conditioning unit, which will take up space. Most camper owners forget this part of it and may be frustrated when the time comes to install the panels and the framework. Check with your camper manufacturer what weight and where the mounting points are for the roof. If you need to go above that, you need to get the frame and the roof fortified by adding crossbars or steel frames. Keep in mind, though that will raise the weight of the camper. Ensure that the axels can handle it and that the tow is rated for the additional weight.

SAVE AND EARN MONEY WITH A SOLAR POWER SYSTEM FOR CAMP

Does camp solar power sound attractive? The main advantage of camping solar power is that it saves you tons of money every month. On the electric bills, you will generally save more than 80%.

Moreover, you're going to earn more money. This is because you can sell extra power to the electrical supplier if you produce more energy than your camp has used. The organization will buy additional energy from you according to regulation.

INSTALL A SOLAR POWER SYSTEM FOR UNDER $200

It can now be very cost-efficient to produce solar energy systems for your camper. You can contact other corporations if you are wealthy, but what if you have a tight budget? In reality, you can create your program.

You can note that the cost of solar panels can be reduced from $1000 to $200 with plenty of solar power initiatives. That is why many people think about the creation of their camp-grown solar system.

Power4 camp is currently the most popular service. You can create a robust power system for less than $200 in this software.

BOATS

Boats are a little complicated regarding solar energy consumption calculation. You naturally start with power consumption calculation here as well; however, there are unique factors associated with this calculation.

Solar Panel Size for Topped-Off Batteries

With regards to the energy consumption required when you are not using your boat, some people don't need any energy when a boat is not in use; however, others have pump, lights, or alarm systems that require energy. Some boats can also contain refrigerators or other equipment that require excess energy consumption. You have to incorporate all these factors associated with your energy consumption.

If you need energy just for auto-discharge of batteries, then you can go with small panels of 5-watt size for every battery you have. Make sure you choose the right type of batteries that offer the necessary storage.

Solar Panel Size for Bilge Pump and Other Minor Permanent Loads

In case your boat requires permanent energy consumption, you need to upgrade your solar panel size; however, it will depend on the size of your boat too. The vessel size, cockpit and deck size will help you choose an approximate size, such as 10W, 20W or a higher power size.

You can multiply the amp-hour of the battery with the sunlight period, and then you can choose a complementing size that offers the necessary energy to your permanent loads. For instance, if a 20W panel receives sunlight for about 5 to 6 hours every week, you can get proper energy for 120Ah batteries.

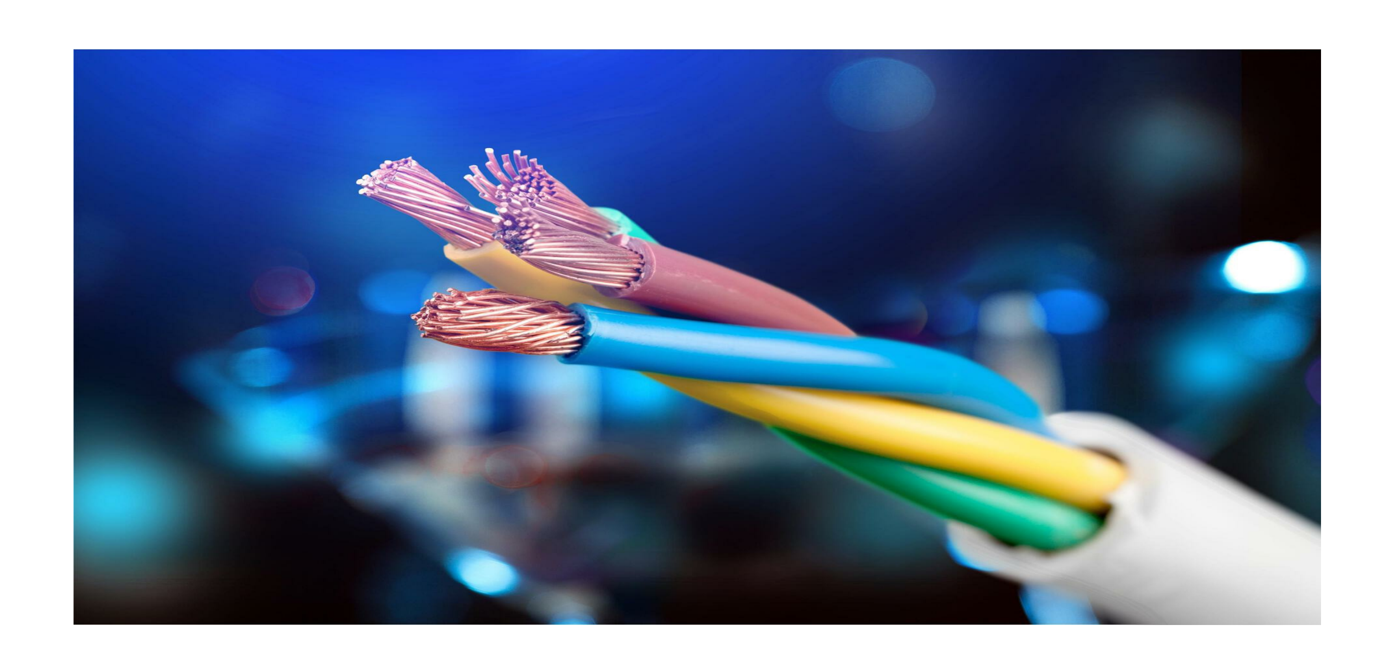
Solar Panel Size for Equipment that Needs High Energy

If your boat has a refrigerator or any other energy-expensive equipment, you need to upgrade your solar panel size. Here, you need to care about the energy efficiency of the equipment. Old equipment requires a higher amount

of power in your boat and you need to make sure that solar panel size can compensate for the energy required to run those devices in your boat.

Solar Panel Size When You Are Away From Land

If you use your boat for long hours away from land, you need to ensure you can consume enough energy and have it available. Calculate the energy requirements of your boat's essentials, and then calculate the hours for which you need energy daily. That is how you will find a clear solar panel size and battery storage requirement for your boat.



CHAPTER 3: WIRING

The electrical wiring of ships is incredibly specialized and dangerous. If you are unfamiliar with this part of the activity, please contact an experienced marine electrician. Your panel is pre-wired for connection to your ship. However, you must supply the connection cables also sold by your panel supplier. They are called MC4 cables. The cables are produced in different lengths to meet your needs, with a plug and socket connection.

You also need a controller. The controller regulates the current from the panel to the batteries and keeps the batteries charged without interrupting the charging process. Many controllers are simple, others have LED indicators showing the amount of charge, etc. The more unusual the functions, the more expensive it becomes. Your panel dealer can suggest a controller that meets your needs. I chose a controller developed by Specialty Concepts. It's simple, but it does the job. The company staff will help you choose the best model for your panel. When you contact them, they want to know what size (power) you are needing and what voltage is required. Check out specialtyconcepts.com. I also received my controller from ‘Sun Electronics’ employees in Miami.

‘Special Concepts’ employees also calculated how heat affects the flow of

electricity and suggests that their controllers should not be installed in engine rooms, as the heat generated reduces the effectiveness of the controller by approximately 25%. I put mine in the control panel under the lower helm. Finally, the right size cables are needed to get from the controller to the batteries and a fuse to connect the controller to the battery bank. When choosing the right fuse, you need to determine the short circuit current for your panel and classify the breaker with 125% of this number. This gives you the amperage of the switch you need. You can also find information on this in the instructions for the use of the controller.

Having a solar panel to save your batteries may seem like a great plan, but you want a way to keep an eye on your batteries. I also decided to install a Trimetric 2025RV battery monitor from ‘bogartengineering.com.’ This smart device is connected to the battery bank to allow a real measurement of the voltage introduced into the bank, the amplifiers used by the yacht, the percentage of a full charge on the bank, and the ampere-hours used since the last charge.

FUSES FOR YOUR WIRING

Why do you need fuses for your PV system in your RV or your boat? The simple answer is that there are rare periods when there is a chance that the wires heat up due to spikes in current, a malfunction in the appliance, or even a short in the wiring due to rodents, perhaps. But when there is a spike and the wires get too hot, they act as a heating filament and a source of ignition. They may be the smallest component of the entire system, but they are undoubtedly the most important when it comes to a mishap.

The first thing you need to remember is that it is not just the amperage of the solar panels but also how you tie them together. If you tie them in parallel, your voltage may be the same but your amps are additive. So if you have 5 amps coming from the first panel, by the time you get to the third panel, the wiring is carrying 15 amps. You need to take this into account when you wire the panels and select the right gauge and the right fuse. If you place a 12-amp fuse on the first segment, that will work, but if you place a 12-amp fuse in the second segment, then that fuse is going to break. One way to do this is to place 12-amp fuses on the solar panel prior to the combiner, and then use a thicker wire to tie them together. If you place them in series, then you will not have this issue.

In the same way, place a fuse after the combiner, after the controller, and after the inverter. Use a 25% rule of thumb above the short circuit current, and fuse each junction. This keeps the entire system safe.

BATTERY PACKS

There are a variety of batteries on the market—everything from the one that your kid uses in his RC car to the battery in your shaver, the battery in your car, and the various batteries that go in the boat, RV, van, and so on. All batteries do one thing—they supply current to something that you wish to power. That is their single purpose. But, as you already know, that is where the simplicity ends. Beyond that, batteries can get extremely diverse and sophisticated, with everything from simple NiCad batteries to complex Li-ions used in advanced aircraft. Along the same vein of diversity, you will find many different quality products, different mission-specific products, various capacities, and even batteries that range from totally hands-off to ones that require constant care and maintenance. For most people, the final choice is a balance of a number of factors, like cost and features.

Right off the bat, we have to distinguish the batteries that go under the hood and the battery that goes in the power bank. They are two different batteries due to different missions. The one under your hood uses only a fraction of its total capacity, but when it is called upon, it has to be ready with a burst of power to turn the engine over.

The one that powers the RV appliances and equipment are the exact opposite. There is not much burst of energy required like the starter, and the power is discharged over a longer period of time until it runs out. This is called deep-cycling. The first takes huge amounts of power in bursts, and the later takes small amounts of power over long periods. The latter lasts longer than the one under the hood.

You’re not going to get a single battery that is going to give you 1000 amp-hours. Here comes your next issue. Most people don’t realize that batteries behave differently when hooked up in series as compared to when they are hooked up in parallel.

The thing that you have to know when you set up batteries in series is that you increase the voltage only, but their amps, and thus their amp-hours,

remain the same as just having one. So if you took ten 12v 100Ah batteries and put them in series, you will get 120V and 100Ah. That's not what you are looking for. What you want with a string of batteries is to keep the voltage the same but increase the amps and the amp-hours. For that, you need to place them in parallel.

When you place them in parallel, the voltage stays the same—12v—but the amps add up, so now you have 1,000Ah. So what you need is to place ten 100Ah 12V deep-cycle batteries in parallel to get what you want.

LEAD ACID OR LITHIUM

There are at least three schools of thought when it comes to deciding on the type of battery that you need. You've already figured out the capacity, but the kind of battery is important because it speaks directly to safety, durability, and reliability. It really comes down to whom you speak to. Some old-timers will swear by the lead-acid, but the newer guys will tell you that the LiFePO4 batteries are superior. We will give you a balanced view here, and in time as you do more RV-ing or sailing, you will get to a point where you will have your own preferences as well.

Before we get into the qualitative issues between the choices, the one point that you should know is that the lead-acid batteries are very different in their charge profiles and in their discharge profiles. Let's do the simple one first. The lithium can be charged in one go; you can bulk charge it from o% to 100% without interruption and even use the batteries while they are being charged. That's the easy part. On the other hand, in lead-acid batteries, you have to charge them in stages. They require three profiles for charging, to be specific, each requiring a lower charge current. The first round is bulk-charging that takes you from 0% to 80%, then from 81% to 95% with absorption charging, and then for the last 5%, you have to float charge it. That alone alters the time it takes to charge a bank of lead-acid batteries fully. The amount of time it takes to charge has consequences on your efficiency and the cost—if you need to increase the battery bank and solar panels to account for delayed charging.

WEIGHT

Let’s start with weight issues. Lead-acid batteries are heavy. If you have to pile on ten of these, you will be placing a huge weight burden on your vehicle. In comparison, lithium batteries weigh approximately a third of lead acids while holding a similar power capacity. Take, for instance, a bank of lead-acid batteries tied to provide 300Ah. They would come in at a whopping 400 pounds. 900Ah would be over 1,200 pounds. On the other hand, a bank of lithium batteries with the same capacity would come in at just under 150 pounds. Think about that in terms of weight to benefit. If you have a small RV, it would exceed the hitch weight, and if you place it in the back, it’s going to destabilize your set up.

SIZE

Comparing lead-acid batteries to lithium batteries, you will find that they are also vastly different in size. Lithium batteries are much smaller and can fit into spaces that similar-capacity leads won’t be able to fit into.

LIFESPAN

When you think about costs as part of your checklists of considerations, you inadvertently have to think about lifespan. The shorter the lifespan, the more often you have to replace something. I look at the cost per day as a good metric for myself or in terms of batteries, cost per cycle. That way, I feel like I amortize the cost of purchase, maintenance, and installation over the item's lifetime. When I apply this rationale to batteries, it becomes clear that lithium batteries come out way ahead. A fairly priced lithium will last about 5,000 cycles, whereas a good lead acid will only be good for between 400 and 500 cycles. A cycle is a full charge and a full discharge. So let's say I pay $1,000 for a bank of lithiums and $700 for a bank of leads, putting all other issues, of size, weight, maintenance issues, and discharge efficiency, each cycle amortizes to 20 cents for the lithium ($1,000/5,000 cycles), whereas the lead amortizes to $1.4 per cycle ($700/500).

VENTING

To some, this may not be an issue, but to many, this is. When it comes to lead-acid batteries, you need to vent them and make sure they vent to the outside. These batteries vent both when they are charged and when they are being used. The fumes are toxic and acidic so you want to be able to release them in a way that it doesn’t find its way back into the interior or to others nearby when parked. It is a requirement that the batteries are placed externally. On the other hand, lithium batteries do not vent any fumes whatsoever and can be placed internally or in a compartment that is accessible from the inside. If you ever have to go out to the battery during winter where you are parked and fiddle around with the battery

DISCHARGE EFFICIENCY

There is one thing that most people do not realize and that is the fact that the appliances that go into the RV, boat, or van add up to be an expensive piece of the puzzle. One of the things that reduce their lifespan is the fluctuation in voltage that could occur when using lead-acid batteries. The lead batteries are notorious for voltage reduction as the batteries drain out. It's like what happens when your AA battery starts to get low and the flashlight dims because of it. That diminishes because the voltage has dropped toward the end of the cycle and if that happens daily, the appliances—many of which have sensitive chips and motherboards—start to degrade in performance. It is not worth it. Lithium batteries, on the other hand, have stable voltage all the way to the last packet of energy.

COST ADVANTAGES

Just about the only place where lead acids seem to win is when it comes to upfront costs. Amp to amp, the lead-acid is about a quarter of the price. A 100Ah lead-acid costs about $200, while a lithium battery costs about $800. The price will vary tremendously depending on where you buy them from and what bells and whistles come with the battery.

When you are trying to set up a 12V 600Ah system that can translate to between $5,000 for lithium batteries versus $1,200 for lead-acid batteries; I get that it can be very expensive when you have just put together all the appliances that are going into a new build—not to mention the cost of the rig itself. But the thing that you should think about is the long-term cost. We have already seen what weight can do, and we have seen how it can affect total weight and the balance of the rig; imagine putting six lead-acid batteries that total up 400 pounds.

CHAPTER 4: SOLAR PANEL

BASIC SOLAR SYSTEM ELEMENTS

There are four major elements associated with any solar system.

Solar Panels

Solar panels, as you already know, receive sunlight energy and change it into electrical energy. The prices of solar panels can differ according to the size and quality you choose. The number of panels will also impact the overall price you pay for the panels, plus, your cost will differ depending on the type of solar panel you select for your needs.

Batteries

Batteries work as storage devices for the energy converted by the solar panels. These batteries are essential and provide different storage capacities according to their amp charging range. You calculate the charging capacity and decide the number of batteries required for necessary storage. This adds to the cost of an overall solar system in your place.

Controller

Batteries can't manage the current flow without a controller. This device is an essential part of the solar system you acquire and regulates the flow of current electricity. This takes a little part of the overall cost you pay for the system; however, it is essential to calculate the price of a controller when you are deciding your budget.

Inverter

The energy stored in the batteries is of no use without your inverter. This device completes the cycle by changing the stored energy to the required voltage, and then this converted voltage reaches the load or equipment.

Therefore, you will have to consider all the four elements mentioned at the time of cost calculation. Also, consider the maintenance and replacement

requirements as well. Batteries usually come with a limited lifespan and require replacement. Knowing this will help you understand the ROI of your invested money in solar power. Finally, you can add up to $1 installation cost for every 1W. Executing it describes more clarity with an accurate price.

CHAPTER 5: CHARGE CONTROLLER

THE CHARGE CONTROLLER: WHAT IS IT?

The charge regulator attempts to take DC sunlight-based force created from the sun-oriented boards and guides it to the batteries for charging. The essential capacity of the charge regulator is to control the force that gets to the battery, so as not to cheat them and danger harming them. This administrative capacity is the reason a few people allude to them as controllers.

The force accordingly remains in DC design right from the sunlight-based boards to your batteries. It possibly experiences 240 volt AC change when an opportunity to utilize it in your RV is near. This transformation is made conceivable through the battery inverter we talked about above. This change coupling is called DC coupling, seeing as the DC sun-powered boards get combined with the DC charge regulator, with a definitive objective of energizing the batteries.

CHOOSING THE CHARGE CONTROLLER

Because of the changing amount of sunshine that is falling on panels, there will be spikes in the output voltage from the panels. Naturally, this is something that we want to avoid. And a solar charge controller should provide a constant charging voltage for our storage system (battery bank).

Having a charge controller is essential in order to prevent surges in voltage, protecting from damage to your batteries, increasing lifespan, and ensuring efficiency throughout the entire solar power system life.

The solar charge controller reduces the voltage of the solar array to the charging voltage of the batteries that is about 14 volts. Most solar panels produce about 20 volts that is much higher than required for charging batteries. In the event of spikes in voltage, the charge controller (for example, MPPT controller) will convert that extra voltage into amperes, thereby limiting the amount of voltage that the batteries will get without losing power. As we already know, volts times amps equals watts. When the solar charge controller reduces the voltage from 18 volts to 14 volts it increases amperage and power on the output of the charge controller will be equal to power into the solar charge controller.

Furthermore, charge controllers may come equipped with safety features such as shutting off charging when voltage spikes up too high, or when batteries have reached max load.

A lot of charge controllers have over paneling protection that is also useful if you decided to add extra panels to your system to maximize power production.

TYPES OF CHARGE CONTROLLERS

Now that we have established the need and importance of installing a charge controller in your solar power system, the time has come to look at the various types of charge controllers.

Shunt - simple 1 or 2 stage controls (rarely used);

- PWM
- MPPT

THE FEATURES OF SOLAR CHARGE CONTROLLERS

Monitors the reverse current flow that can lead to discharging batteries by solar panels - at night voltage of batteries (about 14 volts) will be higher than solar panels produces because the sun isn't shining;

Protects the battery from overcharging – when batteries get fully charged the solar charge controller stops charging batteries that can lead to damaging batteries and keep charging batteries to the full automatically;

- Reduce system maintenance;
- Provides over paneling protection
- Also, a solar charge controller can have:
- Display and/or remote monitoring;

Low voltage disconnect (LVD) – if the battery voltage gets too low, the charge controller will disconnect the DC load and prevents the batteries from discharging more than required or get damaged, the DC load connects to the charge controller;

Temperature compensation to improve and optimize batteries charging depending on the temperature of batteries;

When you go shopping for your hardware, you will find these three main types of charge controllers. Therefore, you need to become familiar with the differences between them.

Simple 1 or 2 stage controls (Shunt controller)

This type of charge controller simply regulates the charge to the desired voltage. This solar charge controller has a shunt transistor that controls the voltage in 1 or 2 steps, simply shorts or disconnects the solar panels when a certain voltage appears.

It is the least efficient type of charge controller but very reliable, there are

very few things that can break.

This type of solar charge controller is rarely used nowadays, so I will not speak a lot about them. But you still can see them on old solar power systems or see some cheap controllers available online.

PWM. (Pulse Width Modulations), efficiency is about 70%, which is another type of charge controller. This type of controller essentially is about 20 to 30% less efficient than the MPPT controller, which means that when we will use a cheap PWM controller on every 10 panels, we will have to add another 3 panels to get the power that we would get by using an MPPT controller (additional few hundreds of dollars). This type of controller is affordable and a good solution for small solar systems - solar panels of which are producing power under high temperatures – between 45 and 75 degrees of centigrade. The controller doesn’t work efficiently if solar panels are shaded. A 20 amp controller costs about 20 to 30$ but is less efficient than an MPPT controller.

To use this charge controller - the nominal voltage of solar panels and battery bank should be the same. A 12 volts panel should charge the 12-volt battery.

This charge controller simply reduces the voltage output of solar panels to the voltage of the battery bank without changing amps, and because of that, there are some power losses and lower performance.

MPPT. The Maximum Power Point Tracking, or MPPT is the most efficient solar charge controller. It tracks the output of the panels in such a way that it can regulate the voltage and amperage and provide the best charging capability without losing power on the output of the solar charge controller. On average, this type of controller can deliver between 10% to 30% higher performance as compared to the other controllers. Efficiency is 95% to 98%. Furthermore, the MPPT controller can compensate for low irradiance levels (less sunlight) or cap the system when there is a spike in voltage due to high irradiance levels. As such, it is the most sophisticated type of controller and, therefore, the costliest. Nevertheless, it is certainly worth the investment and the type of controller you can set and forget about.

It can be used when the nominal voltage of panels is higher than the battery bank nominal voltage. For example, 60 volts (20 volts x 3 = 60 volts) solar array can be charging 48 volts battery bank. Or you can use this charge controller to connect a 20 volts solar panel to 12 volts battery bank.

The ultimate decision on which type of controller boils down to the following criteria:

Solar array size:

- Cost
- Efficiency

If you are looking for the most cost-effective option, you can choose to use a simple 1 or 2 stages, solar charge controller. You need to keep in mind that it is the least efficient controller and almost no one uses it these days, so I don't recommend using them.

In the case of efficiency, the best choice is the MPPT. These outperform the other two types of controller's hands down. As stated earlier, it can increase efficiency anywhere from 10% to 30% which means that the time needed to charge the batteries will be less. This is ideal for climates where sunlight isn’t as abundant or for larger systems, or if you have limited space for mounting solar panels.

As far as sophistication, you would have to decide how much technology you need in your system. A good, middle-of-the-road approach would be to install a PWM controller. This is a solid controller for mid-sized systems or in climates where there is abundant sunlight. PWM controllers also offer the best efficiency-cost ratio. While MPPT controllers are the most efficient, they are also the most expensive. So, it’s up to you to determine whether your budget allows for it.

One other consideration, if you are incrementally building your system. You can spring for a PWM controller while your solar power system is smaller and then upgrade to an MPPT as your system grows. You might not think that it would make sense to invest in two controllers. But it is better to look at it in terms of upgrading your system as opposed to spending on the same item twice.

CHAPTER 6: INVERTERS

WHAT IS THE INVERTER?

The sunlight-based inverter attempts to change sun-oriented control over to 240 volt AC straightforwardly. To lay it out plainly, with an inverter, when the sun is sparkling outside and the sun-based board is getting its energy, you can utilize the force delivered in your RV straightforwardly from the boards without cycling your batteries. To charge your batteries, you have to match the battery up with a battery inverter that is viable. This battery-battery inverter matching is alluded to as AC coupling, seeing as the connection is with AC power in this plan.

An inverter is a device that takes in many wires from a power source that is usually a direct current and changes it to an alternating current, which is utilized by your devices. These usually go by the number of hours that can be channeled through the inverter, and this is simply calculated by multiplying the amount of voltage that you have by the amount of amperage that you have that's going through the system at the time. Almost all inverters do the exact same thing unless you're talking about an alternating current inverter, which is rarely applicable in solar power installations because almost all devices and RV wiring is based on the alternating current

THE THREE KINDS OF INVERTERS

Sine Wave

This is the most preferred type because it allows a very fine control over what you need and it generally is provided by the local electric company. In other words, this is the type of inverter that you actually want in most cases, and buying anything less than this means that you are limiting the number of items that can go on that inverter. It's called a sine wave is because this is what you see whenever you hook it up to a device called an oscillator.

Modified Sine Wave

A somewhat square dip represents a modified sine wave up and below with a slight step in between. This is the middle point between the regular sine wave and the square wave. It actually works with many devices, but since it isn't as refined as the sine wave, you will use a lot more electricity than you would have if you would have bought a regular sine wave inverter. Additionally, modified sine waves are not good for electronics that are sensitive, such as phones or computers. The benefit is that this is cheaper.

Square Wave

This last type of inverter is so uncommon that most people don’t even have it but essentially the wave is square, and it is really only good for basic motors. These are the cheapest you will find.

STEP-BY-STEP GENERAL INSTRUCTIONS TO INSTALL YOUR INVERTER

Install a junction box as you did for the charge controller, but this time install this close to your power bank. You can even install this down in the battery compartment.

In the box, secure the inverter and attach it to a fuse box. Each fuse goes to a line that leads into the RV's cabin and to the different locations planned for a specific appliance.

Use a wire gauge that the manufacturer recommends or larger one.

Secure the connections and make certain that there is no possibility of loose wires detaching from the connections. You want to prevent arcing at all costs.

Next, connect the wiring to the fuse box that goes to the batteries.

At this point, you need to place the power monitors in the cabin and wire them as instructed in the manual. You should have all the wires tied in at this point, and make sure that the disconnect switch is open—meaning that the panels aren't supplying current to the batteries. Check each connection with an amp meter to make sure that there is flow.

A point to note is that all wires need to be connected and insulated. Keep all points of connection dry, and make sure they will not come into contact with water or have the risk of being jarred loose.



CHAPTER 7: HOW TO INSTALL A SOLAR POWER SYSTEM

Each system is composed of some basic components. These components are measured in amperes, watts, or volts. It is easier to think of electric current as water flowing through a tube. Amplifiers measure the volume of water flowing through the tube, volts are like water pressure and watts show how much water the tube could deliver. Use this simple calculation for every part of your solar structure: Ampere x Watt = Volt.

SOLAR COMPONENTS FOR THE INSTALLATION OF SOLAR FIELDS VAN

Every system is different. What you want to feed determines how small or large your system should be. ‘Renogy’ has an online solar calculator with which it is possible to determine what size of the system is needed and what components are needed to power this system.

When we passed, we knew we wanted to live completely off the net for days and didn't have to worry about being connected to the earth. We knew that we would probably run an InstantPot (900 W) and an induction hob (max. 1800W). I wanted the option to run a mixer that usually rises to 1800W. Most of our devices use very little electricity to operate. In essence, our domestic cooler uses compression technology, for example, and takes less than an amp/hour to keep La Croix cold (including vegetables and other things).

SOLAR FIELDS OF VAN

Your system will be unusable without solar panels! The van solar panels were delivered in different powers, but most van lifts use multiple 100W modules for their systems. The modules themselves are easy to install. In excellent condition, a 100W solar module can produce 30 Ah / day. With 3-100W modules, you should be able to charge a 200 Ah full capacity battery in five sunny hours.

To increase the total energy consumption, it is necessary to add five or six panels to the roof or an additional self-supporting panel that can be removed on sunny days.

Solar panels are available in two types of crystalline silicon; monocrystalline and polycrystalline. Polycrystalline sheets are preferred today. Although a little less efficient (around 4%), they are cheaper to manufacture, making them a favorite of commercial and private buyers.

PUT IT ALL TOGETHER

Once you have identified the four main components for the installation of the solar panels of your van, you will have to understand which part is connected to allow a seamless configuration with the van. Once the solar panels are mounted on the roof of your van or camper van, you need to let them pass through the roof. (We used a Blue Sea Systems clamp to prevent water from entering.)

Do not connect the solar modules of the delivery vehicle to the charge controller until the charge controller is connected to the batteries. It could explode!

If you work with electricity in your van, 1) disconnect the solar panels and 2) turn off the circuit.

Further information on the technical data of the individual products, on the fuses, and on the size of the wire and the thickness can be found in the detailed Renogy instructions.

INSTALLING AND SETTING UP YOUR SYSTEM

Now that you are aware of the different types of systems and how few components are required, you may be more interested in establishing your own system. Inverters, battery banks, and cabling are not incredibly expensive. The main cost of a system is solar panels. These are not generally cheap, but the more you have the more electricity you can generate which will help to reduce your dependence on the large energy companies, reduce your environmental impact and even ultimately lower your cost of living. Installing a solar system may even be a necessity if you live off-grid already; understanding what is involved is the first step towards powering your own home.

To complete a successful install and set up your home electricity you will need to consider the following issues:

TYPE OF SYSTEM

The first question you should ask yourself is which system most suits your needs. If you are planning to run your whole house then you will not want to have a direct system. The decision between off-grid, battery grid, and no battery grid will be influenced by your location. If you are not near a current electrical system then the cost of connecting to the grid can be prohibitive; the off-grid system may be the right one for you.

BUYING THE EQUIPMENT

There are many government-backed schemes that will offer to supply you with your solar panels for free, provided you commit to a contract with them. This can help offset the cost of purchasing the panels and restrict your savings and is only an option if you intend to have a battery-less grid system. You will also need to choose a supplier and installer with caution as many of them will charge high rates for the solar panels; this can even offset any savings you may get by using a government grant.

Your solar cell supplier should also be able to supply you with a good quality inverter and batteries, as well as the charge protector. However, these are easy to pick up in a variety of places and maybe cheaper elsewhere.

Before you can buy the equipment, you will have to decide either the number of panels you can afford; you can always expand the system later; or the amount you will need.

IT IS THEREFORE IMPORTANT TO CONSIDER THE FOLLOWING

Location

Solar panels will attract the most sunlight and therefore create more electricity when they are positioned facing due south. This is because the photo-sensitive cells will dramatically reduce productivity as soon as they are placed in the shade. This is not to say it is not possible to generate electricity in a shady spot, but if this is your only or preferred choice, you may need to consider extra panels to gain the power you need.

Choosing the best spot to locate your panels will enable you to calculate how many panels you can fit in a spot and how much electricity you are likely to be able to generate. Of course, it is incredibly difficult to predict an exact amount of electricity as the sunshine is not a constant; you cannot tell which days will be cloudy or wet and windy.

Current Situation

Another important factor to consider which should influence your decision; is which type of system is best for your current situation. There are significant financial implications involved in purchasing a system; an average 3KW system will cost approximately $5,000 and you will need to factor in an inverter, battery bank, and charge controller. An entire system can be installed for $10,000; whilst this is substantially cheaper than it has been this is still a serious financial commitment. Should you have the funds available, you will free yourself from electricity bills for the foreseeable future. However, you will not recoup the money for several years.

There are finance options available, but depending upon your impending

solar install, this may not be the best option. The alternative is to wait or build your system slowly with a long-term solar energy goal and the ability to survive off the grid.

Professional Assistance

If you are keen on undertaking and completing your own projects, you will be pleased to know that it is possible to install a personal solar power system yourself. However, it is also worth obtaining some quotes from professionals. You may be surprised at the cost and will certainly find the system is installed without any hassle. Having said that, not all professional firms have experience with installing off-grid systems; if this is your chosen option, you should confirm they have the knowledge and experience to do the job properly.

STEP-BY-STEP INSTALLATION

Installing a grid-connected system has many challenges and obstacles. The off-grid systems are not a piece of cake either. The installer has to climb a high roof, manage safety issues, and buy expensive components.

Load Calculation

The calculations are based on some appliances (fans, TV, and lights) and their running time. An 11 watt CFL bulb for 5 hours requires 55 watt-hours. Add up all the watt-hours to find the total power requirement.

Battery Selection

Sunlight is not guaranteed, so the battery is needed for energy storage. Deep cycle, lead-acid batteries with deep slow and partial discharge features are the best. Make sure you calculate power, watt-hour, voltage, and capacity. The choice is usually between 12, 24, and 48 volts.

Best Solar Panels

Expensive monocrystalline panels are more efficient than polycrystalline modules. The 125 watts, 12-volt panels assure 480 watt-hours of total power output (4 hours of sunlight).

Superior Charge Controller

They regulate voltage and current between PV solar panel and battery. Excess voltage is converted to amps and charge voltage is optimized for battery storage.

Choice Of Inverter

A pure sine-wave inverter converts battery DC to AC for RV use. Make sure the power rating is equal to more than the total load in watts at any time.

Mounting

Chose the ideal roof location or a stand for mounting the panels. The sunlight

should be bright and without any obstruction in this spot.

Connecting

Set up the serial and parallel connections between the various components. Those who are not confident should take an electrician's help.

Enclosures

The installer places the inverter and battery in ventilated stands or protective enclosures.

WIRING

DC breaker and meter connect the solar panel to charge controller.

From here, the output lines go to battery and DC load.

The battery line runs to the inverter through the meter followed by the DC breaker.

The installer needs to connect the inverter and the AC load to the AC breaker.

TIPS TO HIRE PROFESSIONALS

Not everyone is comfortable with the panel set-up, electrical circuits, and inverters. They may not have the physical capacity or technical understanding to carry out the task. Also, they have to deal with local power suppliers, rules, and regulations. Skillful use of tools, risk analysis, optimal positioning, and hazard recognition are very technical. Such challenges quickly prompt some customers from dropping the idea of a DIY project.

They have no other alternative but to hire a competent and professional company.

CHALLENGES

Householders may not be able to connect the solar power system to the local grid. Building codes and power utility company regulations have to be understood first.

A sizeable set-up can be expensive, and the customers have to be prepared. Insurance coverage can be helpful, but one should contact the insurers for confirmation.

Getting permits from companies and local authorities is not an easy task. Some do not co-operate, while others have a preference for power contractors.

Purchasing sub-standard components for the installation is counterproductive. The power system may not have well-written manuals or set-up instructions.

Self-installation also requires the purchase of sophisticated tools. The equipment does not come cheap, and poorly designed installations are not reliable.

A minimum knowledge of electricity is necessary for setting up solar arrays. DIY projects do not come with a fixed-term warranty either.

HIRING A COMPANY

The customer can hire a trained professional and purchase the solar kit. The better alternative is to approach a reliable, local contractor. There are many benefits of hiring a professional company that specializes in solar power installations.

Contractors have direct links with traders and wholesalers. They purchase the kits and other equipment in large quantities at lower prices.

The skilled installers have a rich experience and knowledge of solar panels. They identify the ideal position and bring their tools for installation.

They are well versed in electrical supply, circuitry, hazards, and risks. Safe installations can guarantee the security of the residents and property.

Minute technical details and safety guidelines are followed to the tee. The installers know all about building, electrical, interconnection, etc., codes, and standards.

TIPS

- Must do a background check on the contractor's reputation and previous work.
- Modern companies have their websites and 24/7 customer support.
- Professionals are willing to perform an on-site inspection and forward a quote.
- They also honor warranties and deliver a well-designed set-up without any delays.
- The installer not only sets up but also assures testing and maintenance.
- Solar power system companies have an efficient and broad social network.
- The complete installation unit completes in a phased or planned manner.
- Transparent contractors are upfront about what they can and cannot do.
- Professionals set up a working system and assure repairs or replacements.

CHAPTER 8: SETTING UP EQUIPMENT AND WIRING THE SYSTEM

At the outset of this book, I encouraged you to walk through your RV and decide where you want to place your hardware. As a general rule of thumb, the best place to install the batteries, the charge controller, and the inverter would be in the same location as your main breaker box. In doing so, you will have access to all of the hardware needed to power your RV or vehicle in the same spot while minimizing the wire losses between them.

First, we place batteries

- Connect the solar charge controller to batteries
- Solar panels to charge controller
- Where to put the batteries
- We will idealistically require a place:
- Insulated from large temperature fluctuation.
- Where the battery can be secured (with a strap) so that it does not tip over (if it is a vehicle).
- A dry place that is protected from moisture.
- Ventilation if you don’t use a sealed battery.

A compartment should be somewhere in the middle of a vehicle between the front and back parts of the vehicle (where is located center of gravity of a vehicle).

One other important safety tip: To reduce the likelihood of your batteries’ terminals coming into contact with any other substance and potentially setting off a fire, you can wrap the positive terminals with a large, flat piece of rubber or at least insulating tape. Rubber doesn’t conduct electricity, and it is very good at isolating sparks and such. So, keep this in mind just as a safety precaution.

WHAT ABOUT THE CHARGE CONTROLLER?

The charge controller is a small piece of hardware that doesn’t weigh very much. So, you can easily mount this on the wall. Preferably, you could mount it about chest-high. That way, you can easily see it and read it.

Think of the placement for your thermostat. You can place it about that high. Also, you want to keep your charge controller close to the entire setup. That way, you can check in on your solar power system once in a while, minimize power losses for wires, and make sure that everything is set up the way it is supposed to be set up.

I would not advise you to locate your charge controller inside the house while your entire setup is in the basement. The reason for this is that if you have the charge controller inside the house while the setup is elsewhere, then you won’t be taking a look at the system as often. By having the charge controller near the hardware, you will be forcing yourself to take a look at your system every time you check the charge controller.

So, the solar charge controllers should be mounted close to the batteries, typically somewhere on a wall. A charge controller has cooling fins for convective ventilation. So make sure that under and above a charge controller is some space for this.

How to mount? Just use some screws or mounting tape if your charge controller is lightweight but not recommended.

WHERE TO PLACE INVERTER?

The inverter has to be placed close to the battery bank so that has minimum power losses for wires. Typically you can mount an inverter on a wall.

CHOOSING WIRES

The efficiency of the system largely depends on the wires (material that the conductor is made from and thickness) you have used in the system; the copper conductor has high conductivity.

Gage size is the overall thickness of the wire. Wire gage size for solar power systems ranges from the thinnest 14 gauge to the thickest 0/4 gauge wire.

The thickness of the wire dependent on the length of the wire and amp load that wire should carry;

If you choose smaller wires required, you can cause overheating, which can lead to fire and huge power losses in the system. If you chose the wrong wire even a fuse will not save you.

Recommendations:

- Always choose a little bit thicker wire than required if it is possible;
- For wiring solar panels, use a solar hook up wire (UV (ultraviolet) resistant);
- For long distances, use thicker wire to conduct current efficiently;

If you don’t want to use thick wires (copper) because they are very expensive or you can’t find one, you can increase the voltage for that wire just by connecting elements of the system (batteries or solar panels) in series.

Wire size recommendations:

If you wire 12-volt panels:

- 10 gauge wire if the length is less than 25 feet;
- 8 gauge wire if the length is more than 25 feet;

If you connect 2 12 volt solar panels in series, you will have 24 volts total, now you can use 12 or 10 gauge wires.

Wiring a solar charge controller (amps) and battery bank:

- 20 amps – 12 gauge
- 30 amps – 10 gauge
- 40 amps – 8 gauge
- 60 amps – 6 gauge
- 80 amps – 4 gauge

Choosing wire for wiring an inverter and battery bank:

Inverter carries a big current and requires very thick wire. If you don't want to look for wires and installing fuse and connectors. You can buy an inverter wiring kit online with an already installed fuse.

- 1000-watt inverter – 4 gauge wire
- 2000-watt inverter – 0 gauge wire
- 2500-watt inverter – 2/0 gauge wire
- 3000-watt inverter – 4/0 gauge wire

For running appliances, you can use 12 gauge or 10 gauge wire *safely*.



CHAPTER 9: MOBILE POWER SETUPS FOR YOUR VAN

Setting up your mobile power system can be fun and exciting if you know what you are doing, are willing to adhere to safety guidelines, and are willing to make some mistakes along the way. Or, if you can, get a licensed installer to do the work and just shadow him while he does his thing. Your first task is to understand the specs and the use of the mobile system you are setting up. If you are setting up for a home, like we talked about in my last book, your considerations will be very different from setting up for a boat, an RV, or a van. The second layer of questions should address the size of the vehicle.

The framework that you need to underscore the thought process is to remember that you can only get out what you put in. What you put in is limited by the amount of sunlight you get and for the time you get it. It's like filling a pail you can only fill when it rains or drizzles. If it drizzles, the bucket fills up slowly. If it pours, the bucket fills up quicker. After the bucket is full, if it keeps raining—either pouring or drizzling—it makes no

difference to the bucket. That bucket will overflow and only the capacity of that bucket will be all that you have. In the same way, once your batteries are filled, all the sun in the world is not going to be able to get you more.

So what does this tell us? The first thing it tells us is that there is an optimal level of solar panels that you can use. It is also limited by how much real estate you have to put it on. If your roof is only 30 square feet, then that's all you are going to be able to install.

Once you have installed that, you have to remember that the sun will be "drizzle" in the early part of the day, rise to its peak when the sun is at the zenith, then start to taper off to a trickle by the time dusk arrives. So you have a bell curve for the amount of solar energy you can collect.

You then have to think about the weather. If it is cloudy or raining heavily, then the panels are not going to be able to pick up much sunlight. At that point, the batteries, which act as a reservoir, will deplete faster than they recharge, resulting in a net outflow. But this is still better than not having any incoming power.

There are a few things that change this equation. The first is efficiency. If your solar panels are highly efficient, then that will compensate for square footage and cloudy days. The second is the type of battery. If you have high-quality batteries, then they will be able to recharge more and at a faster rate. Finally, it depends on what you are using it for and if you have some kind of usage monitor that shuts off unnecessary stuff when there is a lower charge or when there are low battery levels. This is one of the most important things that you can have—active power management to extend the use of your batteries.

Up to this point, we have looked at the whole exercise in theoretical terms and conceptual frameworks. Now, we get started with its reality and the practical aspects of getting it designed and installed. The first is a short questionnaire that you should review so that you can get an idea of what to do.

- Will you be installing or do you already have a generator as a backup?
- Will you be using your vehicle in predominantly cold places, or will you be parking and visiting places that have severe or

depressed temperatures?

- What is the head count of those who will be on board?
- What kinds of appliances run in your vehicle?
- Do you use campgrounds or marinas to plug in and charge your batteries?
- What is the total amp usage for all the appliances that will be used in your vehicle? Always save the booklet that comes with all your appliances when you purchase them. This is a good place to troubleshoot, but for now, it will tell you how many amps each of your appliances are. Here is how you can work it out, shown in an example. You can print this out and use your own appliances to get an idea.

Worksheet - Power Consumption				
Item	**Typical Current (amps)**	**X**	**Hours per day**	**Amp-Hour Consumption**
4 bulb (50 watts)	16	X	12	192
CB receiver	0.5	X	2	1
Stereo	1	X	8	8
Satellite receiver	2	X	5	10
Cooling/Heating	1.2	X	12	14.4
Forced Air Furnace	8	X	10	80
Vent & Range Fan	2	X	2	4
Water Pump	8	X	2	16
DC Fridge	6	X	24	144
Microwave Oven	125	X	1	125
Blender	15	X	1	15
Hair drier 1200w	100	X	0.5	50
Total				659.4

So if all you are going to use is 656.9 amp-hours in a day, then that's the minimum storage you are going to need. Each camper or sailor is going to have different requirements and different safety margins. It also makes a difference if this is your only mechanism or if you have a fuel-driven generator to supplement your electrical needs. Many campers have a couple of strategies. They do the bulk of their charging on bright sunny days, and whatever more they need, they supplement it with generators. But I personally am not a fan of generators as they are loud, and they have both petroleum odor as well as exhaust fumes emanating from them. I'd rather use batteries charged by solar or charged at the marina or campground.

Worksheet - Power Consumption				
Item	**Typical Current (amps)**	**X**	**Hours per day**	**Amp-Hour Consumption**
Total				

With the above table, make a list of all the things that you have in your boat, van, or RV, and then refer to the manufacturer's booklet to get the amp information. Once you have that, get an estimate of how long you use each item on a given day. You really should have two lists. The first list should be for use during daylight hours, and the second list should be for night hours. Once you have an idea of your consumption profile, you will get an idea of

the capacity of batteries that you will need to install.

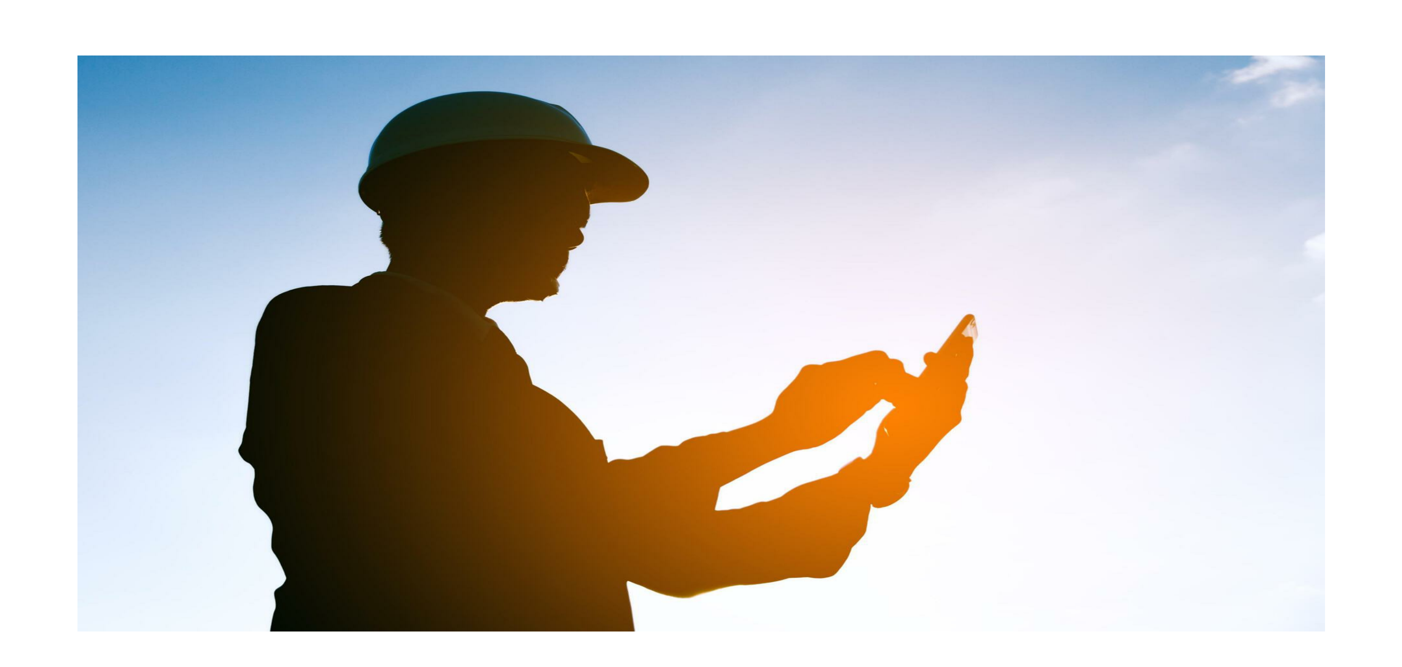
With that done, it brings us to battery packs or power banks. All the charging in the world needs to be stored somewhere, and that's where the batteries come in.

Item	Watts	Amps
AM/FM Cassette	8	0.1
Air Conditioner - Roof Top 13500 BTU	1600	14
Blender	300	2.6
Blow Dryer (Hair)	1500	13
Can Opener	300	2.6
CD/DVD Player	100	0.9
Clock Radio	50	0.4
Coffee Maker (10 cups)	1200	10.4
Corn Popper	600	5.2
Laptop	75	0.7
Printer	240	2.1
Crockpot	250	2.2
Curling Iron	800	7
Electric Blanket	500	4.3
Electric Fry Pan	1200	10.4
Electric Water Heater (6 gallons)	1440	12.5
Fan	300	2.6
Furnace Fan (1/3 HP)	1200	10.4
Heating Pad	250	2.2
Hot Plate	1200	10.4
Iron	1500	13
Microwave	2000	17.4
Power Converter	800	7

Refrigerator/Freezer	1200	10.4
Satellite Dish & Receiver	250	2.2
Shaver	35	0.3
Space Heater	1500	13
Stereo	100	0.9
Toaster	1500	13
Toaster Oven	1200	10.4
TVs-25" Color	300	2.6
Vacuum	1100	9.6
VCR	60	0.5
Waffle Iron	1200	10.4
Washer/Dryer	1900	16

The list above should give you an idea of the wattage that you can figure out using your calculations. This would be the same when applied to boats, RVs, and vans. The one thing that you might want to convert at this point is the watts to amp-hours. If you recall, watts is the product of volts and amps. So if you know your wattage, divide wattage by your voltage. In this case, it is 12 volts and that will give you your amps. Something that uses 1,200 watts on a 12V system means you are using 100 amps. If you use it for 2 hours per day, then that works out to be 400 amp-hours.

This gets you to understand what your consumption profile looks like in both watts and amp-hours. Once you have that, then picking a battery gets easier.



CHAPTER 10: BEYOND INSTALLATION

COMMON MISTAKES WHEN INSTALLING SOLAR PANELS

The installation of solar panels, rather than being a trending topic, is an invention that is helping the planet and our pockets. Investing in a system of solar photovoltaic panels at home contributes to maintaining a great saving in the receipt of CFE.

The interest in the subject of clean energy is growing every day, and doubts always arise, questions when looking for an installer or supplier of solar panels, that is why you must take into account these common mistakes when buying panels solar so you don't make them when you're in that process.

Solar Panels Have Very High Prices

People think that the panels are highly expensive; however, they have to be seen as an investment, not as an expense.

There was a time when the panels were too expensive and it is a date that people still see it as a luxury purchase, but they must consider that having solar panels at home contributes to generating an impressive saving on the CFE electricity bill.

It has always been considered a serious investment for companies and institutions that were looking for savings, even residential buyers preferred not to know the subject because they thought it was quite expensive.

But the cost of solar panel systems has been declining in recent years, and in the same way, their performance and efficiency have improved indescribably. Apart from that, the government and other institutions have shown funding support to promote the use of solar panels both in companies and in homes.

Thanks to this, there are already many companies and homes that save money by taking care of the environment by having a system of photovoltaic solar

panels.

When you go to purchase solar panels, the first thing that your installer has to do is generate a quote, this is based on your current electricity bill and the panels that would be installed, from here they can give you the performance and savings What would you have if you installed the solar panels.

All Solar Panels Are the Same

There are thousands of brands and types of solar panels around the world, and it is quite difficult to tell the difference between various types of solar panels. Typically, companies and companies offer the same information about solar panels, starting with the 10-year product warranty, then the 25-year performance guarantee, and a nominal power, which is usually around 250 WP.

Therefore the best way to say if a solar panel is good or not is to ask for references in other countries and check if there are tests on those solar panels. If there is evidence that certain solar panels are used in large projects in various markets, it means that the solar panels will work perfectly.

The Country of Origin Affects the Quality of Solar Panels

There is a common ideology between companies and consumers that German-engineered solar panels are better than others.

However, judging a product by its country of origin may become only a strategy to convince the consumer through ideologies already raised with other products, and emotionally motivate them to achieve a purchase of solar panels.

However, more than 90% of solar panels imported into Australia in 2013 were made in China. With such an impressive market penetration level, it is hard to believe that Chinese solar panels are of inferior quality.

Technology Is Unstable

Another common misconception about solar panels is that the technology is fairly new, and it is better to wait for a few generations before buying them. Most people don't know that the technology behind photovoltaic modules has been around for more than a century.

While it is fair to say that unstable photovoltaic systems for a long time, recent events have increased the performance of solar panels. And, with the

growing interest in clean energy, there is no better time to invest in solar energy than now.

Solar Panels Only Work If There Is Enough Sun

It is a fallacy that solar power only works in the sun. If your business is in an area where there is not much sunlight, then it is not worth investing in electricity.

Just look at Germany, a country with a fairly rainy climate - they are a solar superpower, getting most of its power from photovoltaic systems. Apart from that, the installers must analyze the area where they are going to be accommodated, and they must give the best positioning to the panels so that they can generate a good amount of energy.

It's Hard to Find a Reliable Installer

With such an overwhelming list of manufacturers and installers, it can be difficult to say the good of the less professional. Apart from the generic information, such as “we have installed 5,000 systems”, it is difficult for consumers to assess the quality of the service experience they are buying.

As a general rule, when you decide on your solar panel supplier, ask for references, preferably from the companies that have already attended.

The decision to install a photovoltaic solar system is one of the best that will bring numerous benefits. But, before buying photovoltaic modules, research and find an installer that can meet your specific needs.

DIY SOLAR POWER GENERATION TIPS FOR YOUR BOAT

Electricity at anchor is almost a must for most sailors or motor sailors, especially if you are traveling with your family. Electricity is needed if the admiral is to use the hairdryer after a hot shower, if hot water is needed for dishes or if you just need to keep the refrigerator cold. A marine solar panel system can generate this electricity silently and efficiently for you.

There are other ways to generate energy; operate the engine(s) or run an onboard or portable generator. Both methods require energy consumption to generate energy. This takes the form of burning fossil fuels. What if I could get the energy for free and then convert it to usable AC / DC electricity? With a system of marine solar panels, you can, and as a bonus, you can design and build the system yourself if you have the minimum mechanical suitability.

The first thing to bear in mind with a DIY project is to determine what is needed to complete the activity. In this case, additional precautionary measures should be taken, as your finished solar panel system must be suitable for harsh marine environments.

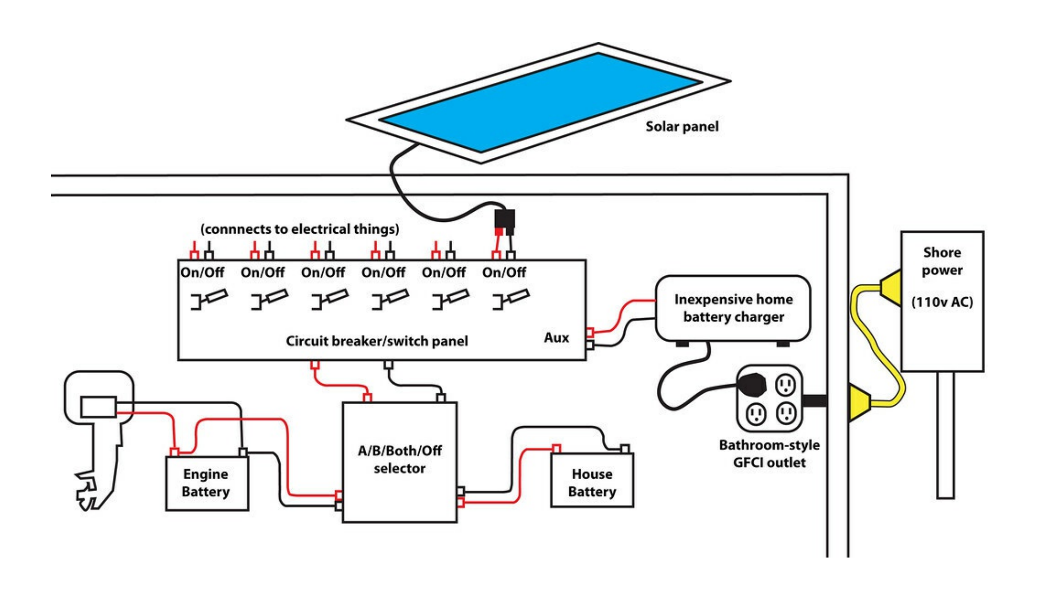
First, you need to determine the overall performance required for your travel style. Add the total energy consumption (in amperes), you would need to add the anchor and divide the total current by 2. This gives you the power you need.

The type of panels to be integrated into the project should also be considered. For example, monocrystalline photovoltaic cells are highly efficient electric generators that take up little space but lose efficiency in low light or indirect solar conditions. Polycrystalline cells take up even less space but still lose efficiency in low light conditions. The other possibility would be the use of amorphous photovoltaic modules, which have a lower overall efficiency with

a larger area at the same time but do not lose efficiency in low light conditions.

Regardless of which direction you choose, keep in mind that there should be at least a general understanding of how electricity is generated with a marine solar panel system. My advice is to research and carefully plan your project to avoid mistakes. When you finish the project and step back to admire your work, you‘ll not only know the sense of self-actualization but also that you’re about to save money (to buy more fuel or drinks).

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CONCLUSION

Congratulations! Now you can install solar panels on your property and enjoy uninterrupted electricity to go about your everyday life.

The best way for you to get the most out of your solar system is to keep the panels clean and to make sure that the wirings are always snug. Every week, do a walk-around and inspect your equipment to look for degradation, rust, snug fit, cuts, tears, and anything that shouldn't be there. Make it a point to inspect your battery compartment and make sure there are no critters nesting in there or any fluids leaking. If you have a gasoline generator and hardly use it, run the generator during your inspection days. Don't let fuel stay in there and degrade. Also, make sure that all the wiring to the generators is in good order.

Above and beyond that, you should send your RV to a maintenance shop to inspect and fix things, or you can do it yourself once a year. Replace wiring that you think needs it, change housing and protective covers, and grease the hinges to panels and frames.

The right way to live in this world is to make sure that there is continuity in our everyday activities, many of which are connected with electricity. But for electricity to reach the rural areas, it will take time, though you now have the power and knowledge to build one.

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